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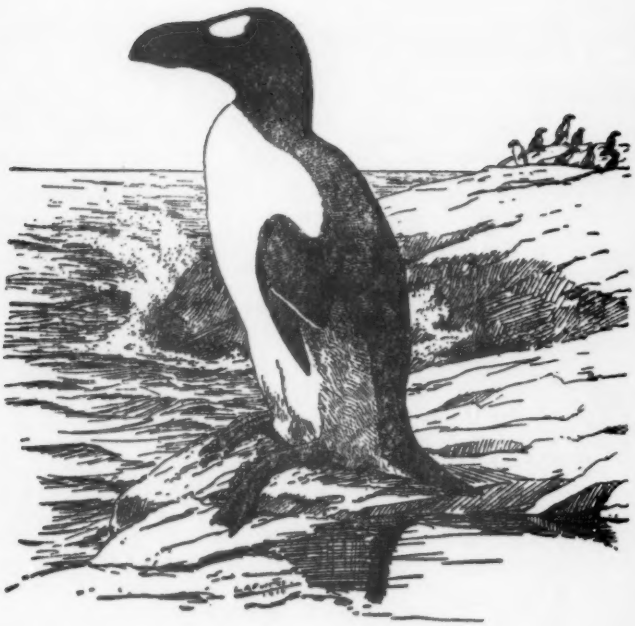

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INTERSPECIFIC PREENING INVITATION DISPLAY OF PARASITIC COWBIRDS

ROBERT K. SELANDER AND CHARLES J. LA RUE, JR.

BROOD parasitism holds special interest for the student of behavior, since adoption of this highly specialized way of life, which has evolved independently in five avian families (Miller, 1946), involves not only the loss of nesting and parental behavior but also the development of a complex of new patterns of behavior adapting the parasite to the host. Specialization for parasitism is most marked in the European Cuckoo *(Cuculus canorus)* and related forms of the subfamily Cuculinae (Chance, 1940) and perhaps least so in the cowbirds (Icteridae) of the New World, which have very closely related, nonparasitic relatives and have had a comparatively short evolutionary history as parasites (Friedmann, 1929, 1955). A considerable volume of information on cowbirds has been provided by the pioneer work of Friedmann (1929) and later studies by Nice (1943), Hann (1941), Norris (1947), Laskey (1950), Mayfield (1960, 1961a and b), and others, but we are still far short of an adequate understanding of the biology of these birds. In particular, the complex behavioral interactions occurring between parasite and host, both at the time of egg laying by the cowbird and during the course of development of the cowbird in the care of the foster parents, are essentially unknown.

Early in the course of studies on the behavior of the Brown-headed Cowbird *(Molothrus ater)*, beginning in February 1959, we noted that captive cowbirds persistently approached individuals of certain other species of birds and invited heteropreening of the head and neck by adopting a special head-bowed posture (Figure 1). Surprisingly enough, repeated presentation of this display was often effective in inducing other species to preen the cowbirds' plumage. Subsequently, we obtained a number of field records of this behavior in Brown-headed Cowbirds, and a similar display was seen in captive Red-eyed Cowbirds *(Tangavius aeneus)*. It would seem, therefore, that heteropreening invitation is a regular, although hitherto unstudied, part of the behavioral

repertoire of these parasitic icterids. The behavior is all the more unusual in that cowbirds only infrequently direct the invitational display to members of their own species and do not themselves indulge in social heteropreening.

The present report deals almost entirely with preening invitation in the Brown-headed Cowbird, and, unless otherwise indicated, the term "cowbird" refers to that species. It is our hope that this paper will stimulate other workers to observe and report further instances of the use of this display by cowbirds in the field, since the significance of this behavior can be judged only when an abundance of field records is available.

DISCOVERY OF THE DISPLAY

The display was first seen on 27 February 1959, while we were observing a group of 22 Brown-headed Cowbirds in a large, outdoor aviary. A male cowbird approached a female cowbird and displayed, at which point the female flew. Later in the day, a male directed display to another male resting on a perch; and, as the displaying bird approached, the resting bird pecked it away.

When this behavior was first observed, we suspected that it represented an intraspecific display in some way associated with courtship or pair formation. However, this supposition proved to be erroneous, and the normal use of the display became apparent when other species of birds were placed in the aviary with the cowbirds. On 3 March, a few minutes after a meadowlark *(Sturnella)* was introduced, several cowbirds approached it and displayed. At first the meadowlark simply retreated to a new position, often flying to another perch, at the approach of the cowbirds; but, later the same day, we noted that the meadowlark was less prone to flee and now often remained in a fixed position, pecking at the cowbirds as they displayed. Next day, the meadowlark sometimes responded to the display by preening the cowbirds rather than fleeing from them. And for a period of two weeks during which the meadowlark was confined with the cowbirds, preening became the usual response of the meadowlark to any cowbird in display. As a consequence, the meadowlark was "victimized" to the extent that it spent several hours each day in this activity.

In late March, several female Red-winged Blackbirds *(Agelaius phoeniceus)* were placed in the aviary, where they remained through the summer and fall. A day or two after their introduction, they were seen to preen displaying cowbirds, and this behavior was noted hundreds of times in the following months.

DESCRIPTION OF THE DISPLAY

We have used the term "display" for this behavior since it involves distinctive postures and movements having obvious communication function, inducing, normally, flight, attack, or heteropreening in the individual to which it is directed, hereafter called the recipient. In display (Figures 1A, 1B, and 1D), the head is bowed to a point at which the bill is directed either vertically downward or in toward the cowbird's body. The feathers of the head and nape are conspicuously ruffed, but other body plumage is generally slightly compressed or sleeked. The wings and tail are held in normal resting position, and the cowbird is often slightly crouched.

Assumption of the head-bowed posture is accompanied or shortly followed by a movement of the cowbird toward the recipient. This may be a sidling motion along a perch or a direct head-on approach. Usually the cowbird halts when its head is about one inch from the recipient, but the approach may continue until the top of the cowbird's head is actually placed against the breast of the recipient (Figure 1A). Orientation of the cowbird's body with respect to the recipient's position varies: frequently the body is oriented along a perch as frontal

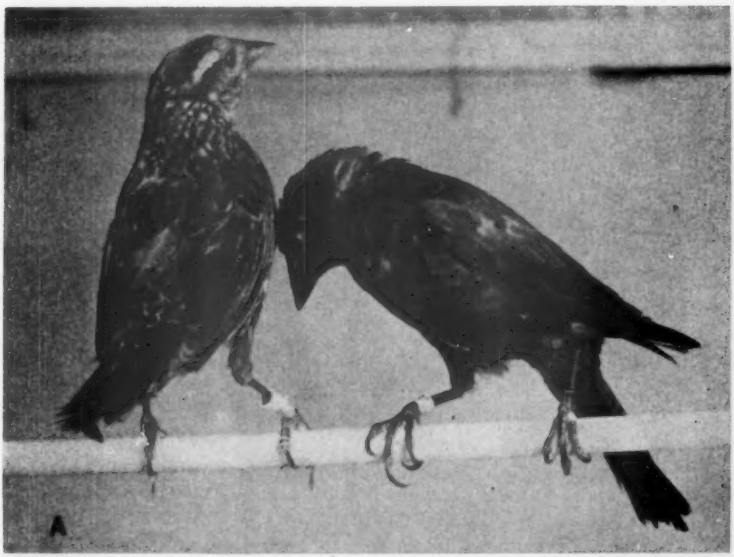

Figure 1A. Male cowbird gives preening invitation to female Red-winged Blackbird.

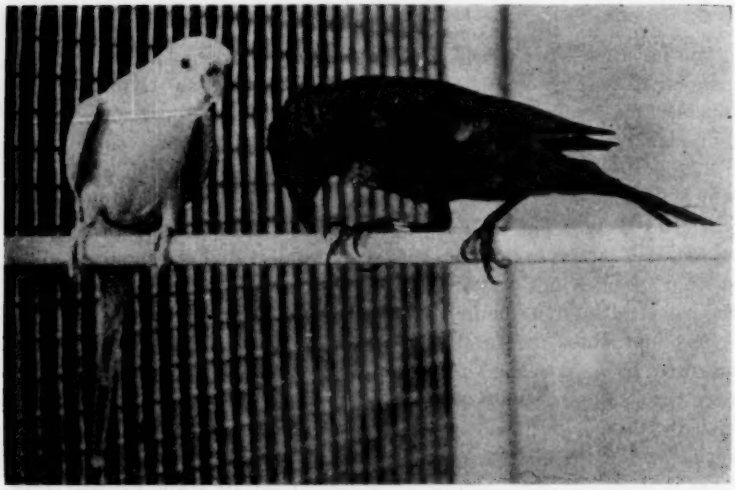

Figure 1B. Female cowbird invites preening from a Shell Parakeet.

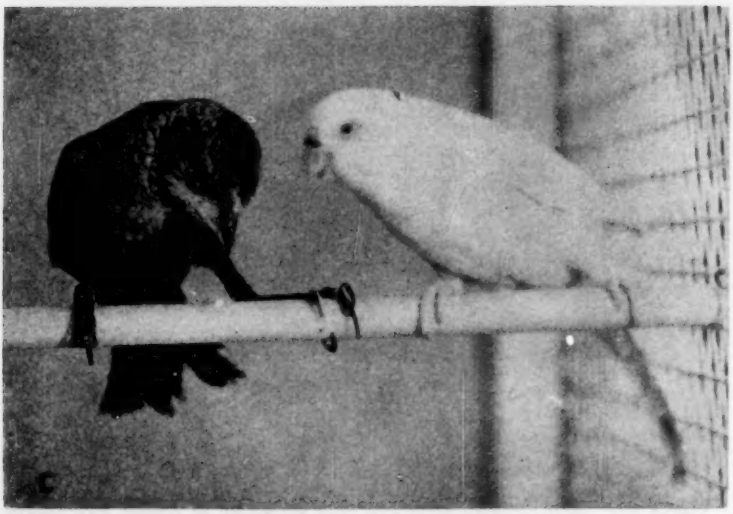

Figure 1C. Displaying female cowbird dodges peck by Shell Parakeet.

presentation of the head is made (Figure 1B), but cowbirds also posture with the body at an angle, often about 45°, to the recipient. Or the cowbird may perch side-by-side with the recipient, bowing the head and cocking it toward the recipient. Oblique presentations are most likely to be used when the recipient is in the habit of pecking at the displaying cowbird; this permits the cowbird to dodge the blows by turning rapidly away (Figure 1C).

Regardless of the orientation of the displaying cowbird's body, the cowbird postures in a position in which the occipital region of the head is directed toward the head of the recipient. While presenting the fluffed feathers of the head, the cowbird maintains a rigid pose, avoiding rapid or sudden movement; and it avoids direct visual fixation of the recipient. In the displaying cowbird, the eyes have a characteristic "glassy" appearance. The display is not accompanied by vocalizations.

Display is given on perches, on the ground, or while both the recipient and the cowbird cling to the wire sides of an aviary or cage. If heteropreening is induced, the cowbird maintains the bowed posture and continues to avoid sudden movement, although it may make slight changes in position of the head, as if to encourage the responding recipient to preen particular regions.

THE DISPLAY IN CAPTIVE BIRDS

All our observations of the preening invitation display in cowbirds confined to aviaries and cages have involved adult and first-year indi-

Figure 1D. Male cowbird displays to dummy White-crowned Sparrow.

viduals captured in the spring in the Austin region, Texas. We have not yet had an opportunity to study this behavior in juveniles or in immature individuals less than six months old; but James Baird (pers. comm.) has observed the display in a two-month-old juvenile female held in a cage with a female Red-winged Blackbird.

INTRASPECIFIC PRESENTATION

As we have indicated previously, a cowbird only occasionally directs the display to another member of its own species. In several hundred hours of observation of several groups of cowbirds confined to aviaries and cages in the absence of individuals of other species, we have noted intraspecific presentation of the display on no more than 25 occasions. Our records indicate that it is most likely to occur among cowbirds that have been deprived of contact with other species for long periods. Also, the frequency of intraspecific presentation usually rises for a brief period following the introduction of an individual of another species.

In all recorded instances of intraspecific presentation, the display was given only a single time and invariably resulted in withdrawal or

Figure 1E. Agonistic behavior of two male cowbirds, each intent on soliciting preening from dummy White-crowned Sparrow. The bird on the left is beginning ruff-out display as the other bird gives head-up display; both displays have threat function.

Figure 1F. Male cowbird at height of ruff-out display to dummy White-crowned Sparrow.

attack on the part of the recipient cowbird. Most frequently the recipient cowbird pecked at the displaying cowbird as it approached, and this brought an end to the episode. In no instance did intraspecific presentation of the display lead to heteropreening.

INTERSPECIFIC PRESENTATION

Response of the recipient. Individuals of other species placed in an aviary or cage containing cowbirds initially respond to the approach and display of the latter either by pecking or fleeing. The reaction of female Red-winged Blackbirds is typical of the latter type of response. As the recipient blackbird retreats a step or two, the cowbird quickly follows and again displays at close range; and this behavior may occur repeatedly along a perch. If the recipient flies, the cowbird may follow at once, or it may remain momentarily in display before flying after the retreating recipient, to display at the new position. If the recipient makes no overt response to the displaying cowbird, the latter moves forward a half inch or so, adjusting its position to bring the head more precisely into direct view of the recipient; and soon the cowbird's head may come to rest against the recipient's breast (Figure

1A). Usually this contact induces the blackbird to retreat or to peck at the cowbird.

The usual initial response of the domestic Shell Parakeet *(Melopsittacus undulatus)* when placed in a cage with a cowbird is to peck and bite as the latter approaches. In response, the displaying cowbird dodges by rapidly turning or leaning away from the blow (Figure 1C). Unless the recipient actually moves forward in attack, the cowbird usually keeps its head bowed as it dodges and quickly returns to its former position, with its head about one inch from the recipient.

It is remarkable that cowbirds persist in their attempts to induce preening even in the face of repeated hostile responses on the part of the recipient, especially if the latter is a small species and merely pecks instead of moving forward in attack. To illustrate this point, we have summarized in Figure 2 the results of a test conducted on 13 June 1959, in which a pale-blue adult parakeet and a female cowbird were placed in an observation cage measuring 60 x 60 x 120 cm (2 x 2 x 4 feet). Neither individual had previously had any direct contact

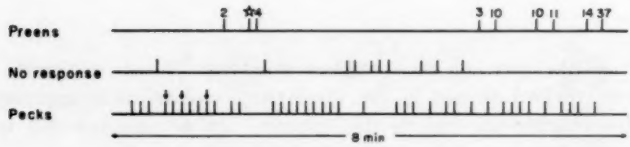

Figure 2. Responses of Shell Parakeet to preening invitation displays of female Brown-headed Cowbird; numbers indicate duration of preening episodes in seconds. ↓ Parakeet strikes cowbird. ☆ Starts to preen, then pecks.

with the other species, although both had been housed for several days in separate cages in the same room. In an eight-minute period, during which the behavior was filmed, the cowbird displayed 58 times and made four intention movements to display. The latter consisted of brief nodding movements of the head given at distances from seven to 15 cm from the parakeet. Two of them occurred in the first 30 seconds of the period, before a full display was given, and the other two occurred just after the cowbird had dodged particularly vigorous pecks by the parakeet. To the displays of the cowbird, the parakeet

responded 39 times by pecking at the cowbird's head. Following the fifth, seventh, and tenth presentations of the display, the parakeet actually struck the cowbird on the head and managed to pull out a feather before the cowbird escaped. Thereafter, the cowbird seemed better able to judge the intentions of the recipient and succeeded in avoiding all other pecks. The parakeet's response to the fifteenth presentation was highly ambivalent; it began to preen the cowbird, then pecked, striking the cowbird's head. About midway through the test period, there was an increase in the frequency with which the parakeet made no overt response to the cowbird's display; and, finally, a number of preening episodes followed. It will be noted (Figure 2) that these gradually lengthened, with the parakeet continuously preening the cowbird for 37 seconds at the end of the period. In the course of this episode, the parakeet twice attempted to "bill" with the cowbird, but the latter refused, moving its bill aside.

During the test period, the parakeet, which was accustomed to small quarters, perched more or less calmly; but the cowbird, which had not previously been confined to a small cage, was obviously distressed. Other disturbing factors included our presence at one end of the cage, four photoflood lamps directed on the cage, and the sound of a movie camera. Between displays, the cowbird flew about attempting to escape, and presentations in the first few minutes of the period were very brief. In anthropomorphic terms, the cowbird's displays suggested the performance of a "nervous" habit, for they were directed in an "offhand" fashion whenever the cowbird happened to find itself near the parakeet. In this situation it was particularly clear that the causal basis of this behavior involved something other than a simple "need" for preening of the feathers.

That the parakeet was induced to preen the cowbird soon after they were placed in the cage should be considered in light of the fact that heteropreening is a normal part of parakeet social behavior. In subsequent tests involving the same individual parakeet but other cowbirds, the parakeet showed even less readiness to peck on first encounter with a cowbird. About an hour after the first test, another female cowbird was placed in the cage. It at once assumed the invitational posture, and the parakeet responded by preening the head and neck of the cowbird for a period of 35 seconds; and several similar episodes followed. In a third test a few days later, the parakeet preened a cowbird's plumage for a period of four minutes and 45 seconds, with only two brief interruptions occurring as the cowbird adjusted its position on the perch. This was the longest preening episode recorded in our study.

Occasionally the recipient bird may respond to the cowbird's display by mounting and attempting copulation. Griffin (1959) watched a male House Sparrow *(Passer domesticus)* attempt to copulate with a male cowbird as the latter was, according to our interpretation of Griffin's notes, giving preening invitation display. He notes that the cowbird "had its head bowed with the lower mandible touching the breast feathers and the wings slightly raised at the shoulder." The position of the wings, as described by Griffin, is not typical and suggests the presence of some behavioral tendency not noted in our birds, but other aspects of the cowbird's behavior were typical; it followed the sparrow about and nudged it when no response to the display was forthcoming. Griffin reports that the sparrow mounted the cowbird four times and that the episode continued for from five to eight minutes; heteropreening was not observed.

A second record of this type is supplied by Teale (pers. comm.), who saw a male House Sparrow mount a male cowbird four times on 4 January 1954. Teale's notes do not indicate whether or not the cowbird evoked this behavior by giving preening invitation display, but it is probable that this was the case. In addition, Behrendt (1960) reports that House Sparrows that are preening displaying cowbirds sometimes climb on their backs.

That male House Sparrows sometimes respond to displaying cowbirds by attempting copulation is not surprising, since, as previously noted by Eisenmann (footnote to Griffin, 1959), the display posture bears some resemblance to that of a sexually receptive female. In particular, the rigidity of the pose probably serves as a potent stimulus releasing copulatory behavior. Many birds, including both House Sparrows and Brown-headed Cowbirds, can be induced to mount lifeless dummies (Allen, 1934; Howell and Bartholomew, 1954; Selander and Giller, 1961; Thompson, 1960), and, in fact, as noted beyond, captive male cowbirds occasionally responded in this way to dummies of other species presented in attempts to induce preening invitation display.

Variation in frequency of presentation. In testing the reactions of cowbirds to dummies of other species (see below), we detected a decrease in readiness to display in late summer during the annual molt. This variation we are inclined to regard as a reflection of the reduced general activity level characteristic of molting birds rather than an effect of changing levels of sex hormone production, for cowbirds with active gonads in April and May exhibited no greater readiness to display than did sexually inactive birds in December and January. Moreover, bilateral castration of males does not affect their readiness to display,

as indicated by a test conducted on 14 April 1960, in which a female Red-winged Blackbird was placed in a small aviary containing seven normal males, ten castrated males, nine normal females, and nine ovariectomized females. The castrations and ovariectomies had been performed in January 1960, and the cowbirds had been deprived of close contact with individuals of other species for a period of four months. In two 30-minute periods, the number of displays given by the cowbirds was recorded. Distinctively colored bands permitted recognition of the normal and castrated males; but, as the females were not color banded, no distinction was made between the two groups. The results of the first test period and a second period following the first by two hours, during which the blackbird remained with the cowbirds, are shown in Table 1. In the first 30-minute period, castrated and normal males gave equal numbers of displays, an average of 2.7 for

TABLE 1

NUMBER OF DISPLAYS DIRECTED TO A FEMALE RED-WINGED BLACKBIRD IN TWO 30-MINUTE PERIODS

		First period		*Second period*	
	No. of cowbirds	*No. of displays*	*Mean no. displays per bird*	*No. of displays*	*Mean no. displays per bird*
Castrated males	10	27	2.7	52	5.2
Normal males	7	19	2.7	14	2.0
Total, all males	17	46	2.70	66	3.88
Ovariectomized and normal females	18	64	3.5	55	3.0
Total, all birds	35	110	3.14	121	3.46

each individual. The 18 females gave a total of 64 displays, or an average of 3.5 per individual. In the second test period, the numbers of displays given by females and normal males decreased slightly, but the mean number given by castrated males increased to 5.2, largely as a result of the efforts of one especially persistent individual that alone displayed 25 times. Preening was not performed by the blackbird, which made repeated attempts to escape from the unfamiliar aviary and rarely spent more than a few seconds in any one position.

Eight intraspecific presentations of the display were noted in the first test period, and nine were seen in the second, whereas no displays were given in the hour preceding the first test.

There appears to be no marked sexual difference in readiness to display, although we suspect that females are slightly more persistent in their efforts to approach other species.

A considerable degree of individual variation in frequency of display was noted. This is shown by a test made on 4 April 1960, when a female Red-winged Blackbird was placed in a small aviary containing five male and five female cowbirds that were color banded for individual recognition. The cowbirds had not been in contact with other species for three weeks. The blackbird had been housed with another group of cowbirds for a one-year period and had developed the habit of preening in response to the display.

The response of the cowbirds to the blackbird was immediate; in a one-hour period, the 10 cowbirds gave a total of 265 displays (Table 2). Of the males, *Green* gave 93 displays, whereas *Red* gave only 2. This

TABLE 2

INDIVIDUAL VARIATION IN NUMBER OF DISPLAYS DIRECTED TO A FEMALE RED-WINGED BLACKBIRD IN A ONE-HOUR PERIOD

Males[1]	*No. of displays*	*Females*	*No. of displays*
Red	2	Red	3
Orange	17	Orange	23
Green	93	Green	1
Pink	3	Pink	60
Purple	5	Blue	58
Totals[2]	120		145
Average number of displays per bird:	24.0		29.0

[1] Males arranged in order of position in dominance hierarchy, Red being the alpha individual.
[2] Difference between sexes not significant at 95 per cent level of confidence.

trial supported previous observations that had suggested that the alpha male in a dominance hierarchy of males is less prone to display than are birds midway in the hierarchy, and that birds low in the order also display relatively infrequently. In females, there was also notable individual variation in frequency of display, but we are unable to correlate this variation with position in the female dominance hierarchy, which was not determined and, in any event, is poorly defined in cowbirds.

The data in Table 2 again demonstrate the persistence with which

cowbirds display to blackbirds. As in the test conducted on 14 April, the blackbird almost invariably flew at the approach of the cowbirds and was greatly disturbed by the unfamiliar surroundings. As the blackbird flew from perch to perch and to the wire sides of the aviary, one or more cowbirds followed, displaying whenever she remained perched for a moment.

In the course of the one-hour observation period, we recorded several agonistic interactions between cowbirds and between the blackbird and cowbirds as follows:

"*Green* male pecked away two female cowbirds which were displaying simultaneously to the blackbird, then he went into display; when no response from the blackbird was forthcoming, he butted her breast with his bowed head; this induced the blackbird to fly.

"*Orange* male, displaying to the blackbird, is displaced with a peck by *Pink* male, who then displays.

"*Green* male pushes aside a female to get near the blackbird. He displays for 15 seconds then pecks the blackbird once.

"Toward the end of the hour, *Green* male displays twice, then catches hold of the blackbird's tail with his bill; she flies and he chases her back and forth across the aviary; when she comes to rest on a perch, he displays twice again.

"*Blue* female, after displaying 19 times to the blackbird, pecks, then bites at the blackbird's tail; the blackbird flies and she follows, displaying four more times.

"*Blue* female displays, then bites the wing feathers of the blackbird and holds on; the blackbird flies and she follows, displays, and is pecked on the head by the blackbird. Eight seconds later, *Blue* female grasps the blackbird's tail with her bill and a fight ensues in which the blackbird dominates after repulsing *Blue* female with a hard peck to the head. A few seconds later, the blackbird pecks *Orange* female as she approaches and displays. *Blue* female again approaches, displays twice, pecks at the blackbird's wing, displays eight more times, and then catches hold of the blackbird's tail; the blackbird flies and *Blue* female follows, again pecking and biting at the tail of the blackbird.

"*Orange* male is pecked on the head as he displays; he retreats four inches, starts to display again but stops as the blackbird gives a peck intention movement; *Orange* male straightens up and flies away."

The effect of an individual of another species in increasing the frequency of intraspecific presentation is illustrated by the following episode: "*Green* male moves toward the blackbird and begins to display. The blackbird immediately flies and *Green* male turns to display to *Pink* female for two seconds; then he flies after the blackbird and again displays."

As a general rule, cowbirds do not behave aggressively toward the recipient until they have presented the display a number of times and have failed to induce preening. In the hour observation period, *Green* male, displaying a total of 93 times, pecked or otherwise attacked the blackbird three times, and *Blue* female, displaying 58 times, attacked

the blackbird seven times; all aggressive behavior occurred in the second half of the period. Other cowbirds did not behave aggressively toward the blackbird. Similarly, when presented with a dummy bird, cowbirds typically display a number of times, then behave aggressively toward it (see below).

THE VARIETY OF SPECIES ELICITING DISPLAY

We have had opportunity to observe the reactions of captive cowbirds to a small number of species of birds confined with them in aviaries for periods ranging from a few weeks to several months or introduced for brief test periods. In addition, we have attempted to test the reactions of cowbirds to a variety of species by wiring museum study skins cross-wise to perches (Figure 1D). Unfortunately, these dummies proved to be much less effective than living birds in evoking the display, and our efforts to apply this technique were hindered further by seasonal variation in responsiveness on the part of the cowbirds, to which we have already referred. In April, strong responses were given to a number of dummies, but, in July and August, even those dummies to which cowbirds had been most responsive in April sometimes failed to induce the display and were at best effective in stimulating displays in only one or two individuals of a large group. Despite this change in responsiveness of cowbirds to dummies, the level of response to live birds remained relatively constant. In a 10-minute test on 6 July 1960, a female dummy Red-winged Blackbird failed to evoke the display in seven cowbirds that had been deprived of contact with other species for a period of six weeks. Yet when a live female blackbird was substituted for the dummy immediately following the test period, all seven cowbirds at once responded, delivering a total of 160 displays in a 30-minute period.

Observations on the reactions of captive cowbirds to other species are summarized in Table 3. Since little effort was made to control many of the factors that could affect readiness of cowbirds to display, the results of our crude tests probably have little significance other than indicating that cowbirds will respond to a wide variety of species and suggesting the existence of some variation in the effectiveness of different species in evoking the display. We will reserve comment on the possible significance of this variation for the Discussion section of this paper.

In addition to the records shown in Table 3, we have an interesting report from James Baird on the behavior of a captive female cowbird that was held in a cage in a room with a small group of tropical finches:

the latter were confined to a separate cage on the wall above the cowbird's quarters. Baird notes that "the cowbird spent a great deal of time at the end of the perch closest to the finches and would remain in a 'head bow' position for long periods (10-15 minutes). This was so regular that . . . she spent an hour or more each day in this position."

Aggression and copulation in response to dummies. After displaying to a dummy bird, both male and female cowbirds sometimes pecked at the dummy (usually at the cotton "eye") or made an outright attack, employing both feet and bill. Their behavior was thus similar to that seen in cowbirds following display to nonresponsive live birds. In addition, male cowbirds occasionally mounted the dummies in attempts to copulate or showed ambivalence between tendencies to copulate and to attack. For example, on 17 June 1959, a male displayed to a dummy Robin *(Turdus migratorius)* for 37 seconds, then pecked at the Robin's head, mounted, and attempted copulation. Dismounting, the male again displayed briefly, pecked at the dummy, mounted, and vigorously attacked the dummy from above. Later the same day, this male also attempted copulation with a dummy Brown Thrasher *(Toxostoma rufum)* and followed this attempt with an attack.

A dummy female House Sparrow also elicited ambivalent behavior in a male cowbird, which displayed, stepped up on the back of the dummy, and pecked at the head. A dummy female Red-winged Blackbird was also mounted by a male cowbird; after the copulation attempt, the cowbird dismounted and attacked the dummy's head, pulling cotton from the "eye."

Considering the wealth of evidence supporting the thesis that an aggressive tendency underlies the courtship and mating behavior of birds and other vertebrates (Morris, 1956; Tinbergen, 1954), overt expression of this tendency by cowbirds responding sexually to dummies is neither unusual nor unexpected. Among icterids, attack following or during copulation attempts has been noted on many occasions when Great-tailed Grackles *(Cassidix mexicanus)* or Brown-headed Cowbirds are responding to dummy females of their own species (Selander, MS), and similar behavior has been reported in the Brewer's Blackbird, *Euphagus cyanocephalus* (Howell and Bartholomew, 1954), and other species.

An unusual response of male cowbirds to dummies of other species is the performance of the ruff-out display (Figure 1F), which is normally used both as a hostile display in territorial interactions with other males and in courtship of females (Selander and La Rue, MS). This display consists of a more or less "standard" icterid ruff-out (see

TABLE 3

RESPONSES OF CAPTIVE BROWN-HEADED COWBIRDS TO LIVE INDIVIDUALS AND DUMMIES OF OTHER SPECIES

	Species	*No. of individuals*	*Response*
I.	Live individuals confined to aviary with cowbirds for periods of two or more weeks.		
	♂ ♂ Red-winged Blackbird (*Agelaius phoeniceus*)	2	Moderate numbers of displays evoked; preening rarely induced.
	♀ ♀ Red-winged Blackbird	3	Frequent display evoked; preening became habitual.
	Meadowlark (*Sturnella* sp.)	1	Frequent display evoked; preening became habitual.
	♀ ♀ Red-eyed Cowbird (*Tangavius aeneus*)	3	Displays infrequent; no preening.
	♂ ♂, ♀ ♀ Great-tailed Grackle (*Cassidix mexicanus*)	20	Two brief displays to ♀ ♀ noted; none given to ♂ ♂; no preening.
	♂ Common Grackle (*Quiscalus quiscula*)	1	Negative (no displays or preening).
	(Feral) Rock Dove (*Columba livia*)	4	Negative
	♂ ♂, ♀ ♀ House Sparrow (*Passer domesticus*)	4	Displays fairly frequent; preening induced.
II.	Live individuals confined to aviary with cowbirds for periods of from 10 minutes to one hour.[1]		
	♂, ♀ Inca Dove (*Scardafella inca*)	2	Numerous displays followed by attack in which doves were injured; no preening.
	♂ Cockatiel (*Leptolophus hollandicus*)	1	Many displays; no preening; Cockatiel very aggressive and cowbirds unable to approach closely.
	♂, ♀ Shell Parakeet (blue variety) (*Melopsittacus undulatus*)	3	Frequent display evoked; extensive preening induced.
	Mourning Dove (*Zenaidura macroura*)	1	Negative
	♂ Domestic Canary (yellow) (*Serinus canaria*)	1	♂ cowbird displayed through wire separating adjacent cages; no opportunity for preening.

TABLE 3—*Continued*

Species	*Response*
III. Dummies (study skins) wired to perch of aviary for 5- to 10-minute periods.[2]	
1. Loggerhead Shrike *(Lanius ludovicianus)*	1 display
2. White-crowned Sparrow *(Zonotrichia leucophrys)*	11 displays
3. Starling *(Sturnus vulgaris)*	Negative[3]
4. Chimney Swift *(Chaetura pelagica)*	Negative
5. Brown Thrasher *(Toxostoma rufum)*	1 display[4]
6. Killdeer *(Charadrius vociferus)*	Negative
7. Meadowlark *(Sturnella* sp.)	5 displays
8. Cedar Waxwing *(Bombycilla cedrorum)*	4 displays
9. Blue Jay *(Cyanocitta cristata)*	Negative
10. Robin *(Turdus migratorius)*	2 displays and a copulation attempt and attack
11. Screech Owl *(Otus asio)*	Negative
12. Yellow-breasted Chat *(Icteria virens)*	Positive[5]
13. ♂ Cardinal *(Richmondena cardinalis)*	Positive
14. ♂ Rufous-sided Towhee *(Pipilo erythrophthalmus)*	Positive
15. ♂ Hooded Oriole *(Icterus cucullatus)*	Negative; two cowbirds approached but seemed too apprehensive to display.
16. Eastern Kingbird *(Tyrannus tyrannus)*	Positive
17. ♂ Painted Bunting *(Passerina ciris)*	Positive
18. ♂ Prevost Cacique *(Amblycercus holosericeus)*	Negative
19. ♂ Myrtle Warbler *(Dendroica coronata)*	Positive
20. ♂ Ladder-backed Woodpecker *(Dendrocopos scalaris)*	Negative
21. ♀ Red-winged Blackbird *(Agelaius phoeniceus)*	Positive

[1] In addition to the species listed, captive cowbirds were seen to display to Evening Grosbeaks *(Hesperiphona vespertina)* and lovebirds *(Agapornis* sp.) in tests conducted at the Laboratory of Ornithology, Cornell University, in October 1960.

[2] The dummy Loggerhead Shrike was presented to a group of 10 cowbirds for 10 minutes and remained in the aviary an additional 60 minutes while dummies of species 2 through 7 were presented in successive 10-minute periods on 8 April 1960. At the end of the series of tests, a live Cockatiel was placed in the aviary and induced 13 displays in a 10-minute period.

Dummies of species 12 through 21 were presented to a group of seven cowbirds in successive 5-minute periods on 5 July 1960.

[3] Negative response also obtained in previous test in 1959.

[4] Evoked copulation attempt and attack in previous test in 1959.

[5] Indicates one or more displays evoked.

Williams, 1952) followed by bill wiping, the two separate activities often but not invariably being "welded" in a single, continuous series of movements. Midway in the display, the cowbird's bill is pointed down as the bow to bill wipe begins. High-speed photographs show that the bird is momentarily in a posture suggesting that of the preening invitation display, but that the body feathers are fluffed and the wings and tail are spread.

THE DISPLAY IN NONCAPTIVE BIRDS

We have shown that preening invitation display is seen repeatedly in aviaries in which cowbirds and other species are closely confined together; and we have indicated that the frequency with which the display is given by captive birds is directly related to the length of time that they have been deprived of contact with other species. In the field, the display undoubtedly is given less frequently, but our own casual observations and those of several correspondents indicate that it is a regular feature of the behavior of noncaptive individuals. Following are summaries of all field observations of preening invitation that have come to our attention; these are arranged under the species to which the displays were directed. It should be noted that we have no field records of intraspecific presentation of the display.

HOUSE SPARROW

Austin, Texas, 29 April 1959. As La Rue watched three House Sparrows and two male cowbirds perched on the screened roof of an outdoor aviary, one cowbird briefly directed display to a female sparrow, which did not respond. *1 July 1959.* La Rue saw a male cowbird pursue a female sparrow along the branch of a willow tree, moving close and displaying whenever the sparrow stopped; hetero-preening was not elicited. *28 November 1959.* Selander saw two males and two females displaying to House Sparrows in mixed flocks at a stockyard. One male displayed to six individuals in turn, going from one to another in rapid succession. The intensity of the display varied from simply perching with bowed head near a sparrow to full horizontal presentation of the head and nape. The sparrows generally hopped, walked, or flew away as the cowbirds approached or assumed the bowed posture; preening was not seen.

Norman Bird Sanctuary, Middletown, Rhode Island, 20 December 1958. The following notes were supplied by James Baird (pers. comm., 4 November 1959). "I was watching a small cowbird flock (20-30) in the backyard. They had finished feeding and were sitting quietly, preening, in the dogwoods . . . or walking about rather aimlessly beneath or near the bushes. With the cowbirds were a number of House Sparrows and White-crowned Sparrows [*Zonotrichia leucophrys*]. My attention was . . . drawn to a female cowbird which had finished preening and started sidling up the branch toward a male House Sparrow which was sitting a foot away. As she approached the sparrow, she pointed her bill toward the ground, thus presenting the back of her head to the sparrow. The

wings were held at rest. . . . The sparrow hopped to the ground and the cowbird immediately followed, running after the retreating male and all the while keeping her head pointed downward. Finally, the sparrow hopped on her back and pecked the back of her head for a short time and then hopped off. The cowbird followed again and the sparrow flew off."

Baird notes that he witnessed cowbirds giving the display to House Sparrows on several other occasions in the winter of 1958-1959.

Weinberg Wildlife Refuge, New York (date not indicated). Ilse Behrendt (1960), watching House Sparrows and a group of 14 cowbirds, including three males and a number of females and "young birds," in bushes near a feeding station, saw "one of the male cowbirds settle down on a branch right under a female . . . sparrow, bending his head and taking a kind of crouching position. Right away the female . . . sparrow . . . [probed] with her bill deep into his head-feathers and worked down all the way to his bill, cleaning and scratching all the spots the bird could not reach himself.

"Sometimes it seemed that it hurt him, for he would suddenly throw up his head and the . . . sparrow would fly away. But the cowbird went after her, taking a branch right under her . . . waiting. And she started to work on him again, over and over.

"I saw four different cowbirds being [preened] . . . by four female . . . sparrows. They worked delicately and gracefully. Sometimes they would climb on the cowbirds' back[s], but then they would slide down and always end up by working from a little higher branch." This behavior was observed for "nearly fifteen minutes."

Stillwater, Oklahoma, 26 October 1958. Griffin's observations (1959) of a male cowbird displaying for a period of from five to eight minutes to a male House Sparrow, which responded by attempting to copulate, have already been discussed.

SCISSOR-TAILED FLYCATCHER *(Muscivora forficata)*

Austin, Texas, April 1959. Donald R. Giller saw a male cowbird display to an individual of this species. The flycatcher flew from its nest on a telephone pole to another pole across a highway where two male and one female cowbirds were perched. As the flycatcher landed on the pole, one of the male cowbirds began a display that continued for about 10 seconds. The episode ended as the cowbird pecked at the flycatcher, which then flew back to its nest.

RED-WINGED BLACKBIRD

Eugene Eisenmann (pers. comm., 22 March 1960) informs us that several people have mentioned to him their observations of Brown-headed Cowbirds being preened by Red-winged Blackbirds; and a full account of observations was supplied by Edwin Way Teale (pers. comm., 24 September 1959).

Baldwin, Long Island, New York, 21 March 1959. At 0630, a female blackbird was seen preening a female cowbird as they perched among canes. As the cowbird held the invitational pose, the blackbird, which was perched slightly above, preened the cowbird's nape. Teale notes that the blackbird "ran its bill horizontally back and forth. . . . At other times it moved it vertically, lifting the neck feathers as it advanced. Again it seemed to work in spots here and there.

Our impression was that it was getting something. At intervals it would stop, withdraw its bill and seem to swallow." This performance, which was in progress when observations began, continued for 10 minutes, terminating as the blackbird suddenly flew to the ground to feed on scattered seed. The cowbird followed and displayed three times again; but the blackbird made no response and the cowbird soon stopped displaying.

At 1630 the same day, a female blackbird (possibly the same individual that was watched in the morning) was seen preening the neck, "shoulders," and face of a male cowbird. "At times the cowbird was pressed close with its head seemingly against the breast of the redwing. The redwing moved about, jumping to other canes in the rose tangle, but always the cowbird followed, coming up a little below and nudging with its head which was bent down, arching its back, [and] getting as close to the redwing as possible." The male cowbird was later joined by a female cowbird and both displayed together to the blackbird. "At times the two cowbirds were pressing against the redwing," one on each side. Once a third cowbird, a female, approached the trio but did not display. Still later, a lone female cowbird displayed to the blackbird and was preened for a few seconds.

Kissimmee, Florida, 13 December 1960. Selander saw a male displaying repeatedly to a first-year male blackbird that backed up along a wire at each approach of the cowbird. Nearby, a female cowbird displayed to a female red-wing. Observations were interrupted when a passing car caused the birds to fly.

THE DISPLAY IN OTHER SPECIES OF COWBIRDS

In the summer of 1959, two captive Red-eyed Cowbirds were occasionally seen to respond to a female Red-winged Blackbird by giving preening invitation displays that were closely similar to those of the Brown-headed Cowbird. Heteropreening was occasionally induced, but usually the Red-eyed Cowbirds displayed for only a few seconds at any one time and were not preened. This we attributed to fright on the part of the cowbirds induced by our presence at the aviary, for, unlike the Brown-headed Cowbird, the Red-eyed Cowbird is difficult to accustom to captivity and remains wary and restless even after weeks of confinement. It is noteworthy that the Red-eyed Cowbirds invariably displayed in a more or less oblique position, which, in the other species of cowbird, is the characteristic position of individuals that have demonstrated a relatively strong tendency to flee as a result of having been attacked by the recipient.

Possibly a similar interspecific preening invitation display is employed by the parasitic Giant Cowbird *(Psomocolax oryzivorus)*, which is, according to Friedmann (1929), closely related to *Tangavius*. Chapman (1928) reports seeing a female Giant Cowbird twice bow her head and present the fluffed feathers of the nape to a female Wagler Oropendola *(Zarhynchus wagleri)* at the latter's nest.

DISCUSSION

The foregoing observations raise a host of questions concerning the motivation, ontogeny, function, and possible adaptive significance of heteropreening invitation behavior in relation to brood parasitism of cowbirds. Final answers to these questions must await further informa-

tion not only on the use of the display under natural field conditions but also on other aspects of the host-parasite relationship. We are also handicapped in our attempt to interpret this behavior by the paucity of available information on the biological significance of intraspecific heteropreening in birds in general. At present we can do little more than offer tentative answers to some of the major questions posed by our findings.

If cowbirds themselves practiced social heteropreening, their solicitation of preening from other species would be less surprising; but, as noted previously, intraspecific heteropreening has not been observed in Brown-headed Cowbirds, and Friedmann (1929) does not mention its occurrence in other cowbird species. It is also clear that the preening invitation display itself is not regular intraspecific behavior that is only occasionally directed to individuals of other species. On the contrary, intraspecific display has not been observed in wild birds; and, working with captive birds, we have found that it is infrequent and may be expected only after cowbirds have been deprived of contact with other species for long periods or following the introduction of an individual of another species, when the cowbirds' "drive" to display apparently increases to a level at which stimuli provided by members of their own species become sufficient to elicit the behavior. Often it is clear that the display is in fact released by the other species and merely redirected to another cowbird.

Among other icterids, social heteropreening appears to be uncommon. Our observations have demonstrated its absence in grackles of the genera *Cassidix* and *Holoquiscalus*, and it is not reported in comprehensive studies of the behavior of the meadowlarks (Lanyon, 1957), Red-winged Blackbird (Nero, 1956), Yellow-headed Blackbird (*Xanthocephalus xanthocephalus;* Nero, MS), and Brewer's Blackbird (Williams, 1952). To the best of our knowledge, the only icterid in which heteropreening is recorded is the Wagler Oropendola, studied by Chapman (1928), who on four occasions saw a female working her bill through the neck feathers of a male as the latter postured with bowed head and half-open bill.

Since "individual distance" (Hediger, 1950) is absent or weakly expressed in many species of birds that have social heteropreening ceremonies, we have considered the possibility that intraspecific heteropreening in cowbirds is somehow precluded by their rigid maintenance of spacing of individuals at distances no less than five inches. Violation of this critical interval invariably leads to rapid adjustment of position, effected by hostile display or pecking, on the part of one or both of the

individuals involved. (As a result, two adult cowbirds come into direct physical contact only while fighting and during copulation; and the latter activity is preceded by mutual mating displays functioning in part to adjust the behavioral tendencies of the participants in such a way that individual distance can temporarily be violated without the induction of overt aggressive behavior.) Following this line of argument, we might speculate that young cowbirds initially approach and direct their displays to other cowbirds when they assemble in flocks in the fall, but that aggressive responses stemming from violation of individual distance result in the young cowbirds becoming conditioned to avoid close approach to others of their species. But arguing against this explanation is the fact that cowbirds persist in approaching Red-winged Blackbirds and other species in the face of continuing hostile responses resulting from the cowbirds' violation of the individual distance maintained by the recipient. And since displaying cowbirds are successful in reducing the aggressive and/or escape tendencies of individuals of other species and are able to induce heteropreening by species that, like cowbirds, do not practice social grooming (for example, Red-winged Blackbirds and meadowlarks), it is difficult to believe that, other factors being equal, persistent display could not evoke the same response in members of their own species. Therefore, it seems necessary to introduce, as a supporting hypothesis, the suggestion that cowbirds, as recipients, are on the sensory side unusually resistant to stimuli provided by a displaying cowbird, or that another cowbird simply does not normally provide the stimuli releasing the display behavior. In either case, the result would be a restriction of use of the display to interspecific interactions.

It is interesting to note that a socially subordinate cowbird that "wishes" to remain in the vicinity of a superior of its own species does not adopt the head-bowed posture; instead it assumes a "sick-bird" attitude, crouching with the body feathers fluffed. This type of submissive display is common to many passerines.

We have previously noted variation in the effectiveness of different species in evoking the preening invitation display (Table 3). In our tests, species of large size were ineffective, no response being given to male Great-tailed Grackles or to the Common Grackle, Rock Dove, and Mourning Dove. But individuals of moderate size, notably female Great-tailed Grackles and the Cockatiel, were effective. And here it is noteworthy that cowbirds do not parasitize species larger than the Mourning Dove (Friedmann, 1929).

Our cowbirds seemed relatively reluctant to display to black or

dark-brown individuals, but otherwise color and pattern of the potential recipient apparently has minor if any significance. We note that cowbirds responded less frequently to male than to female Red-winged Blackbirds, and they displayed rarely to Red-eyed Cowbirds and not at all to the Prevost Cacique, Chimney Swift, and Starling, all of which are black. This may indicate that our captive cowbirds had been conditioned to avoid black individuals as a consequence of previous experience with males of their own species. But it is possible that black is a relatively ineffective releaser (if not an actual inhibitor) quite apart from any conditioning effect. Experiments with individual cowbirds raised in visual isolation from other birds may be required to settle this problem. At present we can only note that the failure of cowbirds to display to the Blue Jay and their relatively weak response to the Loggerhead Shrike perhaps provide some support for the idea that the response is influenced by previous experience. Both species are notoriously aggressive toward other species, and Friedmann (1929) suggests that the absolute freedom from "molothrine annoyance" enjoyed by the shrikes is due to the hawklike habits of these birds. Both shrikes and jays occur commonly in the Austin region, where our cowbirds were trapped.

The whole problem of the influence of previous experience on this behavior is indeed complex. In the Austin region, cowbirds are associated in winter flocks with Red-winged Blackbirds, and they also have frequent contact with meadowlarks and House Sparrows at stockyards and about farms. It is, therefore, perhaps significant that these species were particularly effective in evoking preening invitation display in our cowbirds; but strong response was also given to two exotic species, the Shell Parakeet and the Cockatiel, with which the cowbirds had not had previous experience in the field.

HETEROPREENING IN OTHER SPECIES

Preening invitation postures similar to those of parasitic cowbirds occur in a number of bird species, where, however, they normally function to induce heteropreening by conspecific individuals rather than those of other species. In some species, heteropreening may have no function apart from feather maintenance or the control of ectoparasites; the adaptiveness of this cooperative behavior is apparent since the feathers that are most frequently preened are those that the individual cannot itself reach with its bill. In other species, however, heteropreening ceremonies unquestionably have further significance on a sexual or other social level. Similarly, in mammals, social grooming serves a biologi-

cal function in removing parasites and the like, but at least in the higher primates it is generally agreed that social grooming takes on added significance as a "social service" (Sahlins, 1959).

A display similar to that of cowbirds is reported by Lorenz (1938, 1952) in the Jackdaw *(Corvus monedula)*, in which it has an appeasement function. He notes (1952) that "if one jackdaw wants to show submission to another, he squats back on his hocks, turns away his head, at the same time drawing in his bill to make the nape of his neck bulge, and, leaning towards his superior, seems to invite him to peck at the fatal spot." This behavior illustrates what Lorenz (1952) regarded as "the essence of all the gestures of submission by which a bird or animal of a social species can appeal to the inhibitions of its superior. . . . The supplicant always offers to his adversary the most vulnerable part of his body. . . . In most birds, this area is the base of the skull." This interpretation now seems questionable in light of recent analyses by Tinbergen and Moynihan (1952), which suggest that the bowing and head-turning displays to which Lorenz refers have appeasement function (*i.e.*, reduce the attack and/or escape tendencies of other individuals; see Moynihan, 1955) not in the presentation of a vulnerable part of the body per se but as the opposite of threat movements, an idea previously expressed in Darwin's principle (1872) of antithesis (see discussions by Marler, 1956, 1959). Representative of this class of display are head-flagging movements of gulls (Tinbergen and Moynihan, 1952), and, perhaps also, the bowing of Red-winged Parakeets *(Psephotus haematonotus)* reported by England (1945).

The effectiveness of these displays in reducing the probability of attack lies in the fact that they minimize stimuli for attack by the recipient (Marler, 1957). A similar end may be achieved by presenting stimuli for responses that are incompatible with attack, that is, by diverting the "attention" of the recipient to a nonhostile activity (the "deceptive" displays of Moynihan, 1955). Finally, as noted by Marler (1957 and pers. comm.), reduction of the aggressive tendency of another individual may be achieved by presenting stimuli that are especially evolved for the inhibition of attack.

Returning to Lorenz's description of the Jackdaw display, it seems possible that the head is presented as an invitation to preen rather than to peck. Social heteropreening is common among Jackdaws, and, even if presentation of the fluffed feathers of the nape and head to an antagonist did not actually induce heteropreening, the resemblance of the display to that used to invite "friendly" social heteropreening might have a "soothing" effect, as suggested by Moynihan (1955) in refer-

ence to a comparable display of the Spice Finch *(Lonchura punctulata)*. Observations on captive Jackdaws by Marler (pers. comm.) have recently confirmed our interpretation, for he notes that the display does in fact often elicit heteropreening.

Goodwin (1959, 1960) has recently published some interesting notes on heteropreening in estrildines of the genus *Amandava*. In three species studied, the Avadavat *(A. amandava)*, the Golden-breasted Waxbill *(A. subflava)*, and the Blue-breasted Waxbill *(A. angolensis)*, mutual heteropreening is common; and, in agonistic situations, the subordinate of any two birds is likely to offer its head as an appeasing response to actual or threatened aggression. Goodwin has advanced the thesis that heteropreening "involves sublimated . . . aggression on the part of the preener and submission on the part of the preenee," and he notes that individuals will only permit heteropreening from individuals that are regarded as superiors or equals. Surprisingly enough, "weaker" birds, especially when apparently "feeling depressed or socially insecure through having been defeated in a fight," will approach "stronger" individuals of their own or of other species of *Amandava* and deliberately offer the head for preening. In the solicitation of other species, the behavior of these estrildines resembles that of cowbirds, but it would be premature to conclude that the similarity extends to motivational factors or that the functional significance of the behavior is the same in these two different groups of birds.

In the highly gregarious Bronze Mannakin *(Lonchura cucullata)*, social heteropreening of the head feathers occurs both in pair members and in nonreproductive individuals in flocks (Morris, 1957). A bird invites preening by moving close to another individual and tilting the head as the two birds perch side-by-side. Similar behavior is recorded (Moynihan and Hall, 1954) for the Spice Finch, in which "a bird wanting to be preened tries to incite its immediate neighbor(s) to do so by raising the feathers of the whole head and neck equally, and turning the nape or chin towards the other bird(s)." It is noteworthy that neither species of *Lonchura* maintains individual distance; frequently individuals come into close bodily contact, clumping together on perches to rest or sleep and to clean one another.

Analagous behavior is reported in the Groove-billed Ani *(Crotophaga sulcirostris)* by Skutch (1959), who notes that "while one stretches up its neck its neighbor carefully bills and nibbles at the feathers, possibly searching for insect pests; and when the first has finished its kind office to the second, the latter reciprocates the favor." Again it is noteworthy that anis are social birds showing no individual distance.

In several species of wrens of the genus *Campylorhynchus,* heteropreening ceremonies are a regular feature of the behavior of pair members and presumably function in pair-bond reinforcement (Selander, 1956). When pair members meet after periods of separate foraging or other activity, the female holds a rigid pose as the male carefully preens her head and neck. Preening by the male is interpreted as a ritualized "substitute" for pecking, which actually occurs in one species, *C. brunneicapillus,* in the absence of the heteropreening ceremony.

Among psittacines, heteropreening ceremonies initiated by head-bowed invitational displays are widespread and frequently seem to have appeasement function. We have recently observed heteropreening in captive Cockatiels, Shell Parakeets, and African Grey Parrots *(Psittacus erithacus);* and Dilger (1961) describes this behavior in lovebirds *(Agapornis).* In Cockatiels, a mutual preening and billing ceremony precedes copulation of mated pairs. In a manner suggestive of a cat soliciting head scratching from a human, hand-raised African Grey Parrots will invite "preening" from humans by bowing the head and fluffing the feathers of the head and neck. Analagous behavior is reported in captive Bateleur Eagles *(Terathopius ecaudatus),* which greet humans by bowing the head and inviting scratching (Moreau, 1945).

THE COWBIRD'S DISPLAY AS AN ADAPTATION FOR PARASITISM

We come finally to a consideration of the possible adaptive significance of preening invitation display as manifested by parasitic cowbirds. Perhaps the simplest interpretation is that the behavior represents an exploitation of other species for skin and feather care, with the benefit to the cowbird being limited to the preening that is obtained. But there is no reason to believe that the cowbirds have unusual requirements for preening of the feathers of the head region; nor are they subject to unusually heavy infestations of lice or other ectoparasites (Friedmann, 1929). Moreover, if we assume that cowbirds have special needs for feather and skin care, it is perhaps surprising that the problem of obtaining preening has not been solved by evolution of intraspecific heteropreening ceremonies. Considering all aspects of the problem, we wish to suggest that, while the occasional heteropreening obtained by cowbirds may be beneficial from the standpoint of feather and skin maintenance and may serve to reinforce the cowbirds' tendency to display to individuals of other species, the prime adaptive significance of the behavior is in the effect it has in reducing the hostile

tendencies of individuals of other species that are potential hosts for the cowbirds' brood parasitism.

In the cowbird's display, appeasing elements tending to minimize stimuli for attack include the lack of movement, the careful avoidance of direct visual fixation of the recipient, and the partial or complete concealment of the bill (a major aggressive weapon) by bowing the head. (In contrast, a highly aggressive cowbird that is about to attack moves rapidly, visually fixates the opponent, and adopts a posture in which the bill is directed forward.) At the same time, according to our interpretation, the presentation of the fluffed feathers of the head may be "designed" further to reduce the probability of attack by diverting the recipient's "attention" to the act of preening.

The fact that cowbirds actively seek out and approach recipients may at first sight seem inconsistent with the thesis that the behavior reduces the likelihood of attack; but, as suggested by Marler (pers. comm.), this may actually facilitate the process of appeasement if the cowbird approaches quickly and confidently before the recipient becomes aggressive.

The potential advantages of an interspecific appeasement display are apparent, for it is well known that female cowbirds are attacked by their hosts when they are discovered at the nests; and the furtive behavior of a female cowbird approaching a nest that she intends to examine or in which she will deposit an egg in itself suggests that the female is exposed to the danger of discovery and attack by host individuals (Mayfield, 1960). According to Friedmann (1929) "most birds are so vigilant of their nests that often a laying Cowbird must be subject to considerable attack, or at least be the witness of many intimidation displays on the part of the victims." As an example of the reaction of hosts to the female cowbird at the nest, we may cite Friedmann's observation of a Robin *(Turdus migratorius)* that "began yelling its distress call" and drove her off the nest. Another Robin (the mate), two Catbirds *(Dumetella carolinensis)*, three Yellow Warblers *(Dendroica petechia)*, and one Blackpoll Warbler *(Dendroica striata)* joined in the chase of the female cowbird, "each screaming its loudest." Another example is provided by Prescott's record (1947) of attacks by a Scarlet Tanager *(Piranga olivacea)* and two Red-eyed Vireos *(Vireo olivaceus)* on a female cowbird at a nest of the vireos.

Largely as a result of research by Hann (1941), it is known that the female cowbird not only visits the host's nest to lay but also spends a considerable amount of time in the vicinity of nests, waiting for the appropriate time to deposit her eggs. She watches nest building by

potential hosts for extended periods and makes regular trips of inspection to nests in the absence of the owners (Mayfield, 1961a). In the forenoon of the day before she lays, on the day of laying, or, rarely, on the following day, she usually visits the nest and removes one of the host's eggs; and she may visit a nest in which she has deposited an egg even after incubation has begun (Mayfield, 1961a). Male cowbirds presumably do not visit the nests of hosts, but they do spend time in the territories of host species and are also subject to hostile responses by the hosts. For example, we have seen Red-winged Blackbirds chasing both male and female cowbirds from their territories on several occasions; and hostility of blackbirds to cowbirds is also reported by Sutton (1928).

Hostile responses of Song Sparrows *(Melospiza melodia)* to cowbirds have been described by Nice (1943), who notes that the sparrows habitually react to the presence of adult cowbirds in their territories with vigorous warning notes and threat postures; and, as a female cowbird approaches the nest, the sparrows frequently attack. The following are representative of Nice's field notes on cowbird-Song Sparrow interactions:

> Mar. 30. A female Cowbird spends about 10 minutes in 1M's territority. 1M and K2 [a pair] *tchunk* [warning note] continually, following her closely in trees, on burdocks and on the ground. K2 [female] seems more zealous than 1M. 4M and K3 [a second pair occupying an adjacent territority] are also *tchunking*. 1M flies as though to drive off 4M; returns within a meter of Cowbird with tail spread. K2 utters *zhee* [threat note]. . . . Apr. 3. Male Cowbird comes within a few centimeters of 1M and K2 feeding on the hillside; one of the pair pecks him in the breast; he leaves.

Nice also reports that a presumed first-year Song Sparrow on its territory in the spring was "greatly disturbed" over the courting activities of cowbirds early in the season before nesting had begun.

In American Redstarts *(Setophaga ruticilla)* on their territories, Hickey (1940) found that "males were silent in the presence of female cowbirds, but females reacted with sharp hisses, a rapid snapping of the bill and much spreading of the tail."

Additional records of hostile responses by potential hosts to female cowbirds in the vicinity of nests are given by Leathers (1956) and Mayfield (1960).

Apparently not all host species respond aggressively to cowbirds, for Hann (1937) determined that Oven-birds *(Seiurus aurocapillus)* are heavily parasitized but "do not recognize the Cowbirds at sight as enemies," and he observed (1941) one Oven-bird flee from the nest as a female cowbird approached.

In advancing our speculative interpretation, we are not unduly discouraged by the fact that we have no observations of cowbirds actually using the display to appease hostile host individuals in the vicinity of nests, for few observers have studied the behavior of the cowbird. Moreover, brief presentations of the preening invitation display, especially where heteropreening is not induced, may easily be overlooked or confused with other behavior patterns of the cowbird by an observer not familiar with the display.

Since the effectiveness of display in inducing preening increases with repeated exposure of the recipient to it, the cowbirds' persistent use of the display in the nonbreeding season may be adaptive in conditioning potential hosts to respond in a "friendly" manner, thus increasing the likelihood that the display will be effective in forestalling attack in the breeding season when the cowbirds are in the territories of the host species. Additionally, by using the display in winter flocks, the cowbirds may gain some advantage over individuals of other species in potentially agonistic situations involving food or roosting sites.

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SUMMARY

Brown-headed Cowbirds *(Molothrus ater)* approach individuals of other species of birds and solicit heteropreening by giving a special head-bowed display. Through persistent presentation of the display, heteropreening may be induced from a variety of species, including meadowlarks, Red-winged Blackbirds, and other forms that do not engage in intraspecific heteropreening. Intraspecific presentation of the preening invitation display is uncommon among cowbirds and does not result in the induction of heteropreening.

In captivity, the readiness of cowbirds to display is increased by depriving them of opportunity for close contact with individuals of other species. There is no marked seasonal variation in frequency with which the display is given, and bilateral castration of males does not affect their readiness to display. Preliminary tests with live birds and dummies of other species suggest that cowbirds will not display to species larger than a Mourning Dove and are relatively reluctant to display to birds that are black in color.

A similar preening invitation display was seen in captive Red-eyed Cowbirds *(Tangavius aeneus)*.

Avian appeasement displays are discussed, and it is suggested that the interspecific display of parasitic cowbirds is an adaptation for parasitism, functioning to decrease the probability of attack by individuals of host species by decreasing their aggressive tendencies.

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WATER ECONOMY OF THE CALIFORNIA QUAIL AND ITS USE OF SEA WATER

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THE California Quail, *Lophortyx californicus,* occurs widely in grasslands, brushlands, and woodlands from southern Oregon to southern Baja California, but it does not occupy high mountains or extreme desert areas. It is often found in marginal desert regions where water is frequently mineralized, on several offshore islands, and in areas adjacent to the sea. Therefore, the possibility exists that it may use saline waters for drinking. Consequently, quantitative information concerning the water requirements of the quail and its ability to obtain water from highly saline sources should allow a more precise understanding of the ways in which this highly successful species has been able to occupy areas of seasonal drought and high summer temperatures. Although extensive quantitative data are lacking, it is known that neither the California Quail (Sumner, 1935) nor the Gambel Quail, *Lophortyx gambelii* (Gullion, 1960), requires drinking water for survival or breeding as long as succulent vegetation is available.

MATERIALS AND METHODS

Our observations were made on adult representatives of the widely distributed subspecies *L. c. brunnescens.* The 47 birds used were trapped in the Santa Monica Mountains on, or adjacent to, the UCLA campus between December 1958 and September 1959. The birds were housed in a windowless room on a 12-hour photoperiod (lights on from noon to midnight). Mixed bird seed with a water content varying between 9 and 10 per cent as determined by drying to a constant weight at 100° C was available at all times. The birds had free access to drinking solutions except during studies on water deprivation and minimum water requirements. Room temperatures varied between 18 and 26° C. Humidity was not controlled. Except during the tests of salinity discrimination the birds were housed individually in cages measuring 25 x 25 x 25 cm. The birds were weighed to the nearest tenth of a gram on Mondays, Wednesdays, and Fridays near the end of the dark period. The initial body weights used in our calculations are not the field weights, but the weights after three or four days of maintenance under laboratory conditions with food and distilled water freely available. In those cases in which experimental treatment resulted in significant changes in body weight and the birds were to be used again, they were given distilled water until their weights returned to the normal range and were stable for several days.

The water drunk was measured daily to the nearest 0.5 ml by the use of graduated cylinders equipped with "L"-shaped drinking tubes. The birds were trained to use the tubes by placing a watering cup nearby for several days. One drinking device was used to determine evaporation. Filtered sea water with a salinity of 31.5 parts per 1,000 was obtained from Marineland of the Pacific, Palos Verdes, California. The various dilutions of sea water were made by the addition of distilled water.

The tests for salinity discrimination were run on groups of birds in a cage measuring 37 x 45 x 60 cm. Four drinking devices were arranged around a ring stand at intervals of 90 degrees. The two solutions to be tested were put in alternate drinking devices. To minimize the use of clues other than taste, the ring stand was rotated 90° daily.

RESULTS

The California Quail shows some sexual dimorphism in weight. The mean body weight of the experimental population after acclimation to laboratory conditions was 138.9 g (males, 142.5; females, 135.3).

Dehydration. The changes in body weight of seven females and five males deprived of water but given mixed bird seed *ad libitum* were followed until death. None of the birds was able to maintain body weight. The mean loss was 1.6 ± 0.4 per cent of initial body weight per day, and in all except one case the decline in body weight was essentially linear. In general, the males survived longer and lost weight less rapidly than the females, but the relative weights at death of males and females were not significantly different (Table 1).

Distilled water. The consumption of distilled water by 20 quail tested individually for periods of from five to eight days averaged 5.2 ± 2.5 per cent of body weight per day (Figure 1). The quail

TABLE 1

RESPONSES OF FIVE MALE AND SEVEN FEMALE CALIFORNIA QUAIL TO WATER DEPRIVATION

	Males	*Females*
Days of survival		
Minimum	28	23
Maximum	48	37
Mean	40.6	28.1
Mean % initial wt. lost per day	1.3	1.8
Mean % initial wt. at death	48.4	51.9

showed a slight net gain in weight (Figure 2). The weight-relative water consumption of the females was slightly but insignificantly greater than that of the males (5.7 versus 4.3 per cent body weight per day).

Minimum water requirements. By successively halving the previously determined *ad libitum* consumption of distilled water of each of 10 quail, we determined the daily water ration below which each bird was unable to maintain a constant body weight. The quail were kept on the minimum daily ration for periods of from seven to 14 days.

The mean minimum water consumption adequate for weight mainte-

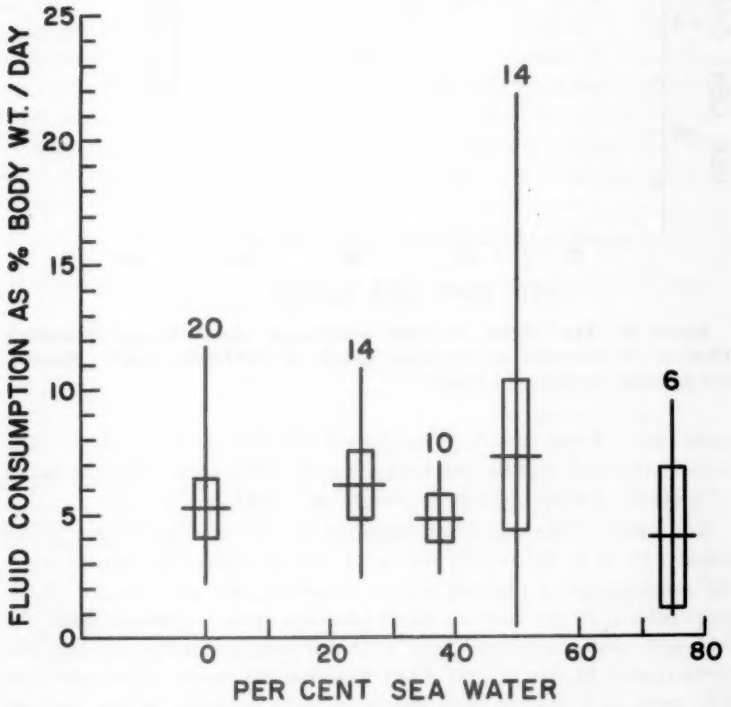

Figure 1. The relations of various dilutions of sea water to drinking by California Quail. The vertical lines indicate the range. The horizontal lines represent the means (M). The rectangles inclose the interval M $-$ $2\sigma_M$ to M $+$ $2\sigma_M$. The numbers indicate the size of the sample. Duration of tests: 25 per cent, 7 days; 37.5 per cent, 14 days; 50 per cent, 9-17 days; 75 per cent, 5 days.

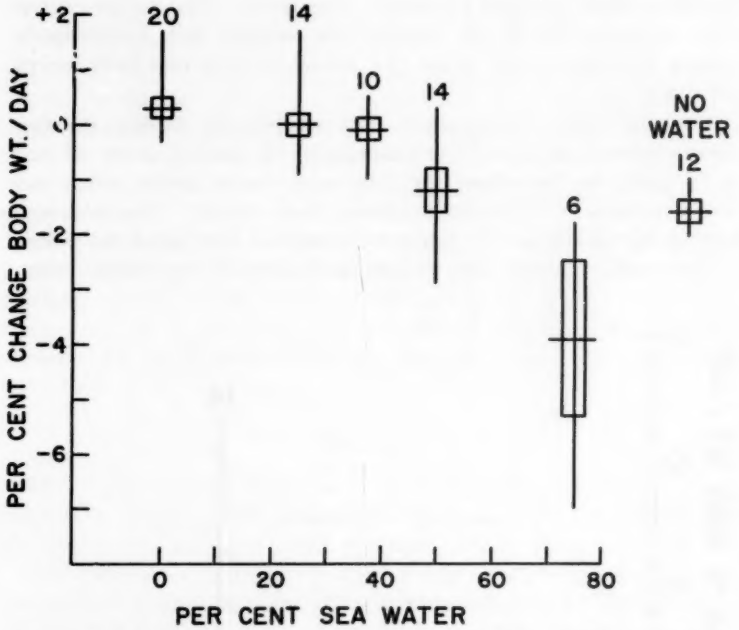

Figure 2. The effects of water deprivation and drinking of various dilutions of sea water on the body weight of California Quail. Symbols and duration of tests as in Figure 1.

nance was 1.8 per cent body weight per day (range 0.9 to 3.6). The females required slightly but insignificantly more water than the males (2.1 versus 1.4 per cent body weight per day).

Sea water. The mean consumptions of all dilutions of sea water tested (25, 37.5, 50, and 75 per cent) did not differ significantly from the consumption of distilled water. However, the performance of the birds offered 50 per cent sea water was extremely variable (Figure 1). Although water ingestion was relatively unaffected by salinity, the birds tended to lose weight when drinking the more saline solutions. The mean daily loss in body weight of birds drinking 50 per cent sea water was not significantly different from that of birds deprived of drinking water. The birds on a regimen of 75 per cent sea water lost more than twice as much weight per day as birds deprived of drinking water (Figure 2).

We undertook to test the relation of water deprivation to ability

to process concentrations of sea water greater than 50 per cent. Ten quail were deprived of water for seven days and then offered 50 per cent sea water for seven days. Those individuals that gained weight while drinking 50 per cent sea water were then given distilled water until they regained all the weight they had lost during the period of water deprivation. They were then dehydrated again for seven days and offered 60 per cent sea water for seven days. This procedure was also used for 70 per cent sea water. Since the birds tested on 60 per cent and 70 per cent sea water were selected on the basis of their ability to process saline solutions, these experiments should indicate maximal abilities to obtain physiologically useful water from dilutions of sea water. Of the 10 birds tested, seven could use 50 per cent, four could use 60 per cent, and one could use 70 per cent sea water. No birds were able to maintain weight on concentrations of sea water exceeding 70 per cent. The birds that obtained physiologically useful water from the test dilutions of sea water drank much smaller quantities than those that lost weight on the same salinities (Table 2). The latter group lost weight essentially as rapidly as birds deprived of water.

TABLE 2

ABILITY OF CALIFORNIA QUAIL DEPRIVED OF WATER FOR SEVEN DAYS TO OBTAIN WATER FROM VARIOUS DILUTIONS OF SEA WATER

(Duration of Experiment, Seven Days. Weight Changes Are Expressed as Per Cent Initial Body Weight and Drinking Is Expressed as Per Cent of Body Weight Per Day.)

	Per cent sea water		
	50	*60*	*70*
Number of birds tested	10	7	4
Mean daily fluid consumption	16.5	17.2	12.4
Mean daily weight change	+ 0.6	− 0.1	− 1.2
Birds gaining weight			
Number	7	4	1
Mean daily fluid consumption	11.2	8.9	8.9
Mean daily weight change	+ 1.7	+ 1.1	0.0
Birds losing weight			
Number	3	3	3
Mean daily fluid consumption	29.0	28.3	13.6
Mean daily weight change	− 1.8	− 1.6	− 1.5

Use of succulent food. To obtain quantitative data on the use of succulent food as a water source by California Quail we deprived eight birds of water for six days and then supplemented their diet of dry grain with shredded cabbage that contained 90 to 92 per cent water by weight. Within four days all the birds regained the weight

lost during six days of water deprivation. To extend the findings above, two freshly captured subadult California Quail were placed on a diet of dry grain and meal worms (*Tenebrio* larvae). During six days the female increased in weight from 107.6 to 129.7 g and the male increased from 101.3 to 125.1 g—gains of more than 3.5 per cent per day. It is obvious that either insects or succulent vegetation offer an adequate source of water for this species.

Salinity discrimination. The quail showed no significant preference for distilled water as compared with 25 per cent sea water, or for 12.5 per cent as compared with 25 per cent sea water (Table 3). They showed, however, a marked preference for 25 per cent as compared with 37.5 per cent sea water. Since California Quail can maintain weight without difficulty on salinities as high as 37.5 per cent sea water without significant changes in fluid ingestion, we assume that the preferences demonstrated above are a function of taste rather than physiological capacity.

TABLE 3

DISCRIMINATION BY CALIFORNIA QUAIL BETWEEN SOLUTIONS OF DIFFERENT SALINITIES

Test solutions	*Mean ml/bird/day*	*Length of test in days*	*No. birds*	*t*	*p*
Distilled water	3.7	6	9	0.41	> 0.1
vs.					
25 per cent sea water	3.4				
12.5 per cent sea water	5.9	7	3	0.84	> 0.1
vs.					
25 per cent sea water	7.7				
25 per cent sea water	10.3	7	8	7.97	< 0.01
vs.					
37.5 per cent sea water	3.2				

DISCUSSION

Physiology. The California Quail, unlike the House Finch *(Carpodacus mexicanus)* (Bartholomew and Cade, 1958), the Savannah Sparrow *(Passerculus sandwichensis)* (Cade and Bartholomew, 1959), and the Mourning Dove *(Zenaidura macroura)* (Bartholomew and MacMillen, 1960), shows no significant change in fluid consumption with change in salinity. However, even though the amount they drink is independent of salinity, normally hydrated quail lose weight when drinking solutions more concentrated than 37.5 per cent sea water.

This weight loss is not necessarily caused by inability to process these salinities. Since these quail show a marked preference for solutions less concentrated than 25 per cent sea water and since they can easily survive for several weeks without drinking, they appear voluntarily to undergo dehydration rather than drink the 50 per cent sea water in quantities sufficient to maintain a positive water balance. If water is withheld so that the birds become moderately dehydrated and then are offered 50, 60, or 70 per cent sea water, they at once drink copiously, and some individuals regain the weight previously lost during the period of dehydration. With the restricted data available to us it is not possible to say whether or not dehydration induces a change in physiological capacity for processing saline water. However, even in the absence of direct measurements it appears that at least some California Quail can concentrate salts in the urine to a level well above that which could be expected in the serum; a few individuals maintained a positive water balance on 60 and on 70 per cent sea water. This is the equivalent of 0.3 to 0.35 M NaCl, which is about twice the osmotic pressure of the blood of the domestic chicken (Korr, 1939:177). The ability of California Quail to survive for a month or more on a dry diet without drinking is consistent with the observation (Bartholomew and Dawson, 1953) that in this species pulmocutaneous water loss is only slightly greater than metabolic water production. The capacity for prolonged survival on a dry diet appears also to be dependent on the fact that this species can tolerate a reduction in body weight of approximately 50 per cent during water denial. No other wild birds for which data are available have so great a tolerance of dehydration.

Ecology. The mean weight loss of California Quail on a dry diet without drinking water is about 1.6 per cent initial body weight per day, while the minimum water required for maintenance of body weight averages 1.8 per cent body weight per day. The rate of weight loss during dehydration is constant. It thus appears that these birds continue to eat normally in the absence of drinking water. Such a response should be of great utility for a bird living in an area of seasonal drought. The observations of Sumner (1935:192) indicate that California Quail do not visit water holes after the first autumnal rains, and, further, in the presence of green vegetation do not require drinking water even during the breeding season. Our laboratory data give a quantitative demonstration of the ease with which members of this species can satisfy their water needs by eating succulent food and insects. California Quail need obtain only a couple of grams of water per day from their food. Therefore, except during the most arid

times of the year or during periods of unusually severe heat stress the securing of adequate supplies of water should present little difficulty.

California Quail prefer water of low salinity and will voluntarily undergo short periods of dehydration rather than drink adequate quantities of solutions more concentrated than 37.5 per cent sea water. Nevertheless, when they become sufficiently dehydrated, they will drink even 70 per cent sea water, from which at least some individuals can obtain adequate supplies of water. Thus, under conditions of severe drought or unusual heat stress saline springs and brackish water could be ecologically significant to the quail living on islands or in marginal desert areas. It appears highly probable that the quail on the offshore islands of California and northern Mexico utilize the abundant succulent vegetation rather than undiluted sea water; on a regimen of 75 per cent sea water captive individuals lose weight at a rate significantly greater than when water is withheld completely.

From a physiological aspect the California Quail is conspicuously better adjusted to water deprivation and to the drinking of saline water than is the Mourning Dove (Table 4). Nevertheless the California Quail is confined to brushlands and grasslands on the margins of the desert while the Mourning Dove ranges widely throughout the desert. This physiological paradox is at least partially explicable in behavioral terms. The doves are powerful fliers that can readily travel many miles to water while quail are weak fliers that are hardly more mobile than a medium-sized mammal. Hence, if this quail is to occupy even semidesert regions, it needs to be physiologically better

TABLE 4

COMPARISON OF WATER ECONOMIES OF THE MOURNING DOVE AND THE CALIFORNIA QUAIL

(The Data on *Zenaidura* Are from Bartholomew and MacMillen (1960).)

	Zenaidura	*Lophortyx*
Water deprivation		
Mean daily loss expressed as per cent initial body weight per day	4.8	1.6
Mean per cent initial body weight at death	63.3	50.4
Mean days of survival	7.3	33.3
Water consumption		
Highest concentration of sea water on which body weight can usually be maintained	25%	50%
Mean daily *ad libitum* consumption of distilled water expressed as per cent body weight per day	9.9	5.2

adapted to aridity than the dove, despite the fact that the dove successfully occupies the desert while the quail cannot.

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SUMMARY

On a dry diet captive California Quail showed a mean weight loss of 1.6 per cent of initial body weight per day. Mean length of survival without water was 28.1 days for females and 40.6 days for males. *Ad libitum* consumption of distilled water averaged 5.2 per cent body weight per day, and the minimum consumption of water on which body weight could be maintained averaged 1.8 per cent body weight per day.

Ad libitum drinking by normally hydrated birds of 25, 37.5, 50, and 75 per cent sea water did not differ significantly from that of distilled water, but birds drinking 50 and 75 per cent sea water lost weight. Daily weight loss of birds drinking 75 per cent sea water exceeded that of birds from which water was withheld completely.

After being deprived of water for a week, seven of 10 birds were able to maintain weight on 50 per cent sea water, four of 10 were able to maintain weight on 60 per cent sea water, and one bird was able to maintain weight on 70 per cent sea water.

Either succulent vegetation or insects offer an adequate water source for California Quail.

California Quail showed no significant preference for distilled water as compared with 12.5 and 25 per cent sea water, but chose 25 per cent sea water in preference to 37.5 per cent.

The low water requirements and the tolerance of dehydration of California Quail allow them to remain independent of surface water as long as green vegetation or insects can be found. Under conditions of severe drought or heat stress brackish or saline water may contribute to survival, but California Quail apparently cannot utilize the sea as a water source. Although they are not successful in deserts, California Quail have lower water requirements, greater tolerance of dehydration, and can utilize water of higher salinity than the Mourning Dove, which is a conspicuously successful desert species. This situation is probably related to the limited mobility of the quail, which precludes periodic visits to distant water sources.

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FLIGHT ENERGY AND ESTIMATED FLIGHT RANGES OF SOME MIGRATORY BIRDS*

EUGENE P. ODUM, CLYDE E. CONNELL, AND HERBERT L. STODDARD

SINCE fat provides virtually all of the fuel for extended migratory flights, the energy available for flight is easily calculated if the total available body fat is known. As described in detail in a previous paper (Odum, 1960a), migration in the sense of long-continued, sustained flight is possible only within fairly narrow metabolic limits. A reasonable estimate of the flight range can be made on the assumption that the energy required for sustained flight is between two and four times "maintenance" or "existence" metabolism, herein defined as the metabolized energy required by caged birds that are not subjected to energy demands above those needed for day-to-day maintenance of body weight and health at room temperatures. Since metabolic rate per gram of fat-free weight appears to be similar for passerines of 10-40 g, the flight range of an individual bird having a given amount of fat can be estimated. Furthermore, the amount of fat in a living bird, or intact specimen, can be estimated from the total weight if the fat-free, weight-wing length relationship has been worked out for the species involved (Connell, Odum, and Kale, 1960). It is the purpose of this paper (1) to illustrate how patterns of migratory behavior are related to lipid deposition, and (2) to present estimates of the flight ranges of migrating birds killed at a Gulf coast television tower located near Tallahassee, Florida.

METHODS

Daily collections of birds killed at the Florida Gulf coast tower have been made by Stoddard during both spring and fall migration periods since the tower was first constructed in the fall of 1955.

Birds killed by striking the tower during nocturnal migration were collected at dawn, or in some cases during the night as they fell to the ground, and stored in deep freeze. Total body fat was determined by a simple, rapid method previously described (Odum, 1960a), which consisted of vacuum dehydration followed by extraction in petroleum ether. Three weights were taken: total wet weight, total dry weight (after dehydration), and nonfat dry weight (after extraction). The differences between the latter two weights provide an accurate estimate of

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total body fat. Wet weight minus fat equals the fat-free weight, which was the weight used as a basis for computing weight-specific metabolic rates.

PATTERNS OF LIPID DEPOSITION

For the sake of discussion it is convenient to consider three classes of migrants in so far as fat deposition is concerned: (1) short-range migrants that become moderately obese, but begin migration before peak deposition, (2) short-range migrants that attain moderate obesity but begin migration after the peak deposition levels have been reached, (3) long-range migrants that become extremely obese just prior to long flights.

The Savannah Sparrow, *Passerculus sandwichensis,* is an example of the first pattern. Birds leaving their wintering grounds in April at the latitude of Augusta, Georgia, generally carry little fat, while many individuals striking the television tower at the same locality on the southward return in late October are moderately fat (Connell, 1959). Although not demonstrated experimentally, it would appear that migratory unrest, or *Zugunruhe,* develops to some degree at the onset of fat deposition, with the result that birds begin short flights before there is very much buildup in fat reserves. In the Savannah Sparrow such flights, which may involve only a local shifting from one field to another, begin in late February. When individuals disappear from their winter locations in March and April, only a small increase in weight is evident. The last birds to leave in May may be moderately fat; it is suspected that these individuals began migration from points to the south, since birds locally banded in winter have disappeared by this time.

A pattern involving increasing body-fat levels as the bird travels northward is probably characteristic of early spring migrants that winter in continental United States. The absence of a pronounced premigratory increase in weight as reported for the Song Sparrow *(Melospiza melodia)* and Tree Sparrow *(Spizella arborea)* by Helms and Drury (1960) and the Purple Finch *(Carpodacus purpureus)* by Bartleson and Jensen (1955) indicates that these species belong to the first category. The triggering of the migratory urge before maximum fat deposition is clearly of adaptive value, since low energy reserves at the start of migration would prevent long flights that might move the bird into unfavorable early spring weather conditions. Also, it appears that a gradual increase in fat reserves during migration is characteristic of land migrants that breed in the far north. It is well known from the

early observations of Cooke (see Lincoln, 1950) that many spring migrants increase their speed of travel as they approach northern breeding grounds, suggesting increasing fuel reserves. Furthermore, many species of small land birds are quite fat on arriving at the breeding grounds in Alaska (Irving, 1960; D. W. Johnston, pers. corr.). Again, such a pattern has survival value, since maximum fat reserves towards the end of the migratory journey would enable the bird to complete the journey quickly when the weather becomes favorable, and, what is perhaps more important, enable the individual to withstand periods of bad weather that often occur early in the breeding season. Less is known about fall migration, but it seems logical to assume that many species, especially those that start early, begin the southward journey with low fat reserves and hence move in short hops. At each stop for refueling the amount of body fat is increased, permitting longer flights as the bird moves southward.

In the second type of pattern as illustrated by the White-throated Sparrow *(Zonotrichia albicollis)* and the White-crowned Sparrow *(Z. leucophrys)*, migration, in many individuals at least, does not begin until after more or less maximum deposition of fat is achieved. Maximum levels in these species are only moderate (up to 25 per cent of wet weight as observed in nature, or as induced experimentally by long photoperiods), but more or less complete deposition occurs on the wintering grounds. Thus, banded individuals that have been present all winter exhibit a striking increase in weight just before they disappear from the locality (Odum, 1949). A pattern of this type is probably characteristic of late spring migrants in continental regions.

The third pattern of migratory obesity is characteristic of long-range migrants that breed in North America but winter in the tropics. Scarlet Tanagers *(Piranga olivacea)* and Ruby-throated Hummingbirds *(Archilochus colubris)* are typical of a group of small land birds that are trans-Gulf migrants, that is, they fly nonstop over at least 1,000 km (600 miles) of open water. Such birds become extremely obese just prior to long flights. In terms of the per cent of live weight, individual Scarlet Tanagers are the fattest birds we have extracted with up to 52 per cent fat (see Table 1). From the standpoint of percentage nonfat dry weight, hummingbirds range higher, up to 350 per cent fat; that is, the dry weight of fat may be three and a half times the dry weight of all other tissues in premigratory hummingbirds. A tabular analysis of the three patterns of lipid deposition together with data on the daily rates of fat accumulation in experimental and wild birds are given in another paper (Odum, 1960b).

TABLE 1

EXTRACTED FAT AND ESTIMATED FLIGHT RANGES OF PASSERINE BIRDS KILLED DURING NOCTURNAL MIGRATION AT A FLORIDA GULF COAST TELEVISION TOWER

Migrating population	*Dates*	*No.*	*Fat levels*			*Estimated flight range in km**	
			Mean fat (grams)	*per cent wet wt.*			
				average	*extremes*	*average*	*extremes*
Zonotrichia albicollis White-throated Sparrow (Fall)	Oct.-Nov. 1956	45	1.45	6.2	1.9-14.2	180	0–580
Passerculus sandwichensis Savannah Sparrow (Fall)	Oct.-Nov. 1956	40	2.25	13.8	6.3-27.6	560	180-1340
Piranga olivacea Scarlet Tanager (Fall)	5 Oct. 1956	29	17.62	42.6	35.3-51.8	2360	1850-3075
Piranga rubra Summer Tanager (Fall)	5 Oct. 1956	44	16.61	40.7	32.6-46.6	2180	1650-2650
Piranga rubra Summer Tanager (Spring)	April 1957	5	5.34	19.0	13.8-25.9	850	520-1240
Dolichonyx oryzivorus Bobolink (Sept.)	8-16 Sept. 1956-57	8	10.25	29.8	21.7-40.9	1490	940-2240
Dolichonyx oryzivorus Bobolink (Oct.)	1-8 Oct. 1956-57	19	17.50	42.0	32.8-49.1	2340	1680-2850
Hylocichla fuscescens Eastern Veery (Fall)	5 Oct. 1957	101	16.57	38.0	9.8-49.1	2040	380-2850
Vermivora peregrina Tennessee Warbler (Fall)	5 Oct. 1957	72	5.26	39.8	30.2-47.9	2160	1510-2760

Wilsonia citrina Hooded Warbler (Fall)	3 Aug.-11 Oct. 1958	30	4.80	30.0	15.5-43.0	1500	650-2380
Wilsonia citrina Hooded Warbler (Spring)	26 Mar-30 Apr. 1958	99	1.53	13.4	1.0-22.9	540	0-1060
Dendroica castanea Bay-breasted Warbler (Fall)	8-30 Oct. 1956	10	4.92	33.0	27.4-37.6	1700	1320-2000
Vireo olivaceus Red-eyed Vireo (Entire fall)	Aug.-Oct. 1956	101	5.47	25.7	4.0-43.4	1220	80-2420
Vireo olivaceus Red-eyed Vireo (Early fall, lean group)	3 Aug.-10 Sept. 1956	13	2.24	13.7	4.0-25.7	560	80-1220
Vireo olivaceus Red-eyed Vireo (Early fall, fat group)	3 Aug.-10 Sept. 1956	16	9.07	38.5	30.8-43.4	2070	1550-2420
Vireo olivaceus Red-eyed Vireo (Single night)	6 Oct. 1956	29	6.92	30.8	8.1-42.2	1550	280-2330
Vireo olivaceus Red-eyed Vireo (Single night)	30 Sept. 1957	48	3.43	18.2	5.9-33.2	800	175-1700
Vireo olivaceus Red-eyed Vireo (Spring)	4-21 Apr. 1957	81	3.09	18.1	3.8-27.9	790	75-1350
Passerina cyanea Indigo Bunting (Fall)	23 Sept.-9 Oct. 1956	55	2.00	13.4	4.4-35.2	550	100-1820

* Estimates based on curve 2 of Figure 1.

FLIGHT RANGES OF GULF COAST MIGRANTS

As previously described (Odum, 1960a), we have used two approaches to estimate flight ranges of birds having a given amount of fat. In the first method the range was calculated for each species on the assumption that the energy required for migratory flight at a speed of 50 km (about 30 miles) per hour is three times the existence level. Since existence energy of passerine birds of 10-30 g fat-free weight averages about 0.05 kcal/gm/hr, flight energy requirement would be 0.15 kcal/gm/hr or 0.003 kcal/gm/km. A bird of 10 g fat-free weight that had 45 kcal (5 g) of usable fat would thus require 0.03 kcal/km and have a flight range of 1,800 km (1,000 miles). Since a small portion of the body fat is a necessary constituent of the physiological machinery and cannot be used as fuel, we have considered the available fuel to be the total fat minus 0.5 g for birds of tanager and thrush size, and minus 0.3 g for warblers and vireos. These estimates for unavailable fat are based on the minimum amounts found in post-migratory individuals.

In the second method flight ranges of hypothetical birds having a fat-free weight of 20 g plus from one to 20 g of fat were calculated, and these estimates plotted against fat as percentage of total weight (*i.e.*, the fat index). Such a curve can be used to estimate the flight range of any species or individual, since the fat index automatically adjusts for different body sizes, at least within the size range of most migratory passerines. Two such curves are shown in Figure 1. The concave curve (dotted line, curve 1) is based on the assumption that flight energy is three times existence energy and varies with the fat-free but not the fat weight. In the previous paper (Odum, 1960a) preliminary flight-range estimates were based on this assumption, since the evidence available at that time indicated that three times the existence level could account for extra energy needed to transport the large amount of fuel present. However, the assumption that the increment in flight range per unit increment of fat is constant (as in curve 1, Figure 1) would tend to underestimate the range of a moderately fat bird.

As pointed out to us by I. C. T. Nisbit of Cambridge University (pers. comm.), the energy required by a small, flapping bird to overcome gravity is probably more important than the energy needed to overcome drag (especially since migratory birds usually fly with the wind). Therefore, Nisbit suggests that energy requirement should increase proportional to total weight. The difficulty with this assumption, of course, is that the bird changes weight as it migrates and metabolizes its fat. Curve 2 in Figure 1 is based on a compromise assumption as

follows: Flight energy of a lean bird is two times existence energy (0.1 kcal/gm/hr or 0.002 kcal/gm/km) and increases proportional to average weight of the bird during the trip, which is to say, in proportion to half of the fat weight at the beginning of the trip. Thus, a bird with a 25 per cent fat index would be 50 per cent heavier at the start of the journey, but average 25 per cent heavier and hence require 2.25 times the existence level. Likewise, three times existence level would be required at the maximum fat level of 50 per cent. Two times existence level for a lean bird fits in very well with what we know about energy requirements of an active bird in the field, while, as already indicated, three times this level is logical for a very heavy bird.

If we are to deal only with laboratory extractions, fat as a per cent of nonfat weight is a better index than fat as per cent total weight. However, the latter index can be at least approximately determined on living birds or intact specimens. As previously indicated, a good esti-

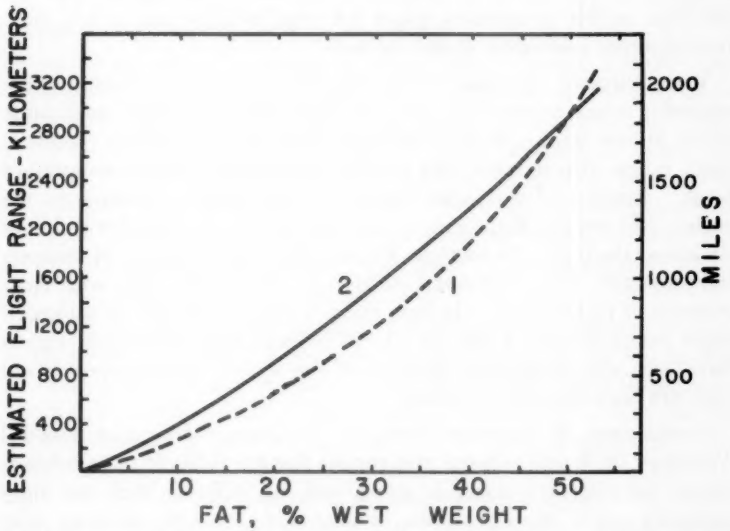

Figure 1. Estimated flight range of small, migratory birds plotted against total body fat in per cent of wet (live) weight. Curve 1 (dotted line) is based on assumption that flight energy is three times the "existence energy" requirement irrespective of weight of the fat. Curve 2 (solid line) is based on the assumption the flight energy is two times existence energy for the lean bird and increases in direct proportion to the average fat weight. See text for explanation.

mate of total fat (and hence the fat index) can be made without extraction simply by weighing the bird and taking its wing length, provided the fat-free, weight-wing length relationship has been worked out for the species in question. Thus, the utility of the graphic method for estimating fat reserves and flight ranges in banded birds or large samples of tower birds is obvious.

Estimated flight ranges (averages and extremes) of birds killed at the television tower based on curve number 2 of Figure 1 are given in Table 1. Included are samples from the entire migratory season as well as samples from single nights when large flights were in progress. Species include two that winter in southeastern United States (White-throated and Savannah sparrows), several that are generally considered trans-Gulf migrants (tanagers), and others whose migratory routes are not well understood at present. All of our data are now being coded and entered on IBM cards so that detailed statistical analyses of relationships between fat and numerous factors such as age, season, year, wind direction, etc. can be made with the aid of computers. For the purposes of this preliminary paper we shall indicate only a few relationships that seem clear at the moment.

White-throated Sparrows, which reach the very southern edge of the wintering range at the Gulf coast, have proved to be the leanest birds killed at the tower; many individuals had no more fat or potential flight range (theoretically zero in some individuals) than nonmigratory birds. Samples of Savannah Sparrows, also winter residents in the region, had greater flight ranges, but would still not have been able to fly across the Gulf. In contrast, fall samples of both species of tanagers indicated that every individual could have crossed the Gulf with large reserves of fuel to spare. In fact, many of these birds had an estimated flight range of over 2,400 km (1,500 miles); such individuals should have been able to continue nonstop all the way to South America had they not been killed at the tower!

Comparison of Summer Tanagers *(Piranga rubra)* and Hooded Warblers *(Wilsonia citrina)*, two species that are believed to be habitual trans-Gulf migrants, taken in spring and fall indicates that our flight estimates are of the right order of magnitude. Spring tanagers were by no means depleted of fat (Table 1); the difference between spring and fall flight ranges in this species was about 1,300 km (850 miles). Likewise, difference in spring and fall estimates for Hooded Warblers was about 1,000 km (600 miles). Assuming that the tanagers and warblers started northward across the Gulf with the same high level of fat as recorded in the fall, then the observed moderate levels in birds

arriving in Florida are what would be expected after a flight of 1,000 km (the minimum overwater distance from Yucatan to the Gulf coast) or more. Furthermore, both species still had ample fat left to continue several hundred miles inland if the weather had been more favorable. The "Gulf coast hiatus" as described by Lowery (1945) is thus easily accounted for by fat reserves still present in birds killed by the Gulf coast tower when they were forced down by thick cloud cover on their northward flight. These results also support our contention that long-distance migrants accumulate more fat than is normally needed to complete any given flight. The reserve is of survival value not only under adverse flying conditions but, also, should food be temporarily scarce at the termination of the flight.

Referring again to Figure 1, we see that a bird with a fat index of 25 per cent would have an estimated flight range of 1,200 km (750 miles). Consequently, allowing for a margin of safety, we would expect that habitual trans-Gulf migrants should have a fat index greater than 25. All 73 fall tanagers, all but six of 101 Veeries, and all 75 Tennessee Warblers so far extracted had a fat index greater than 30, indicating an ability to make trans-Gulf or other long, nonstop flights. The October flight of Bobolinks *(Dolichonyx oryzivorus)* has proved to be consistently fatter than the September flight. During each of three years for which we have specimens, October Bobolinks equalled the tanagers in obesity, while some individuals in September were low in fat content and would probably not have been able to make it across the Gulf. These data strongly suggest that the early flight of Bobolinks follows the Florida-West Indian route while the later flight is trans-Gulf.

Red-eyed Vireos *(Vireo olivaceus)* were the most frequent victims of the tower, and were also the most variable in fat content. As shown in Table 1, the range of variation was great not only for a season as a whole, but also for samples taken from a single night's kill (as on 6 October 1956 or 30 September 1957). In large samples from the 1956 season frequency distribution early in the season was bimodal, with very fat and very lean birds in the same flight; later in the season birds showed a more intermediate condition. Only about half of the total sample of 100 fall birds had an index of over 30 per cent. Since Red-eyed Vireos presumedly follow both the Florida-West Indian route and the trans-Gulf route, it may be that the fat birds would have gone by sea and the lean birds by land!

In general, daily observations of mortality in relation to weather conditions have led Stoddard to conclude that west and northwest

winds in fall bring Florida-West Indian migrants, while northeast winds (the most common direction during nights of heavy mortality) bring trans-Gulf migrants. In regard to vireos, we do not have enough data so far to determine if fat condition is related to wind direction. Interestingly enough, vireos had almost as much fat in spring as in fall (see Table 1), although the maximum in spring was not as great and the minimum less than in fall.

For the most part species that we have found to be consistently very fat in the fall are those that Lowery (1946) and/or Stevenson (1957) list as probable trans-Gulf migrants. An exception is the Indigo Bunting *(Passerina cyanea)*, one of the species Lowery recorded as appearing on ships in the middle of the Gulf. According to our estimates only about six individuals out of a sample of 55 birds extracted would have been able to continue across the Gulf. Most of the individuals would have had to follow the coast or stop for extensive refueling, since the average fat index for the whole group was only about 13 per cent.

Extracted fat and estimated flight range for three species on non-passerines are shown in Table 2, including small samples of swifts and hummingbirds taken far inland from the Gulf Coast. The swifts were collected from a chimney at a season when the species was beginning to disappear from the locality; likewise, hummingbirds were taken from an aggregation described by Norris, Connell, and Johnston (1957) a day or two before the birds disappeared from the flower patch. Flight-range estimates in Table 2 are on less certain grounds, since the long-winged swifts and hummingbirds and the short-winged Soras may have different flight metabolic rates as compared with those of passerines. The flight range of swifts may be underestimated, for example, since these birds may fly with less effort than passerines. On the other hand, the range of hummingbirds may be overestimated, since their small size requires a very high metabolic rate per gram. For hummingbirds an interesting comparison can be made between estimates based on the curve in Figure 1 and estimates based on Pearson's (1950) measurements of the energy required for hovering flight in a bell jar. Using his measurement of 0.4 kcal/gm/hr and a flight speed of 80 km (50 miles) per hour, 2.2 g (19.8 kcal) of fat would result in a flight range of about 1,250 km (800 miles) (see Odum and Connell, 1960) as compared with the estimate of 2,400 km (1,500 miles) as shown in Table 2. Since Pearson found hummingbirds could not maintain hovering for very long, it is reasonable to assume that hovering flight requires more energy than straightaway, migratory flight (with favorable tail winds also a probability). Thus, we are inclined to think that the esti-

TABLE 2

EXTRACTED FAT AND ESTIMATED FLIGHT RANGES OF THREE NONPASSERINE SPECIES OF BIRDS

Species	*Date and location of collection*	*No.*	*Fat levels*			*Estimated flight range in km*	
			Mean fat (grams)	*Per cent wet wt. average*	*Per cent wet wt. extremes*	*average*	*extremes*
Porzana carolina Sora Rail	Tallahassee TV tower 30 Sept.-30 Oct. 1956	8	19.86	27.6	15.1-38.2	1340	630-2020
Chaetura pelagica Chimney Swift	Athens, Georgia—roosting in chimney, 13 Oct. 1959	21	10.51	34.6	29.5-40.6	1800	1450-2210
Archilochus colubris Ruby-throated Hummingbird	Daytime premigratory aggregation, near Augusta, Georgia, 23 Sept. 1955	3	2.25	43.8	41.2-45.9	2450	2260-2590

mate of 2,400 km is more nearly correct. If so, then hummingbirds can easily begin a fall trans-Gulf flight several hundred miles inland. Frequent observations of September aggregations of hummingbirds that suddenly disappear from inland locations when the birds become very fat suggest that these tiny birds may do just that!

Finally, we would like to suggest that bird students obtain weights and wing measurements from birds killed at television towers, as well as from birds captured for banding. From these two simple measurements we believe a good estimate of fat level, and hence flight range, can be made for many species as soon as the wing-length, fat-free weight relationship has been investigated. We will be glad to supply information on the latter for any species for which we have data (see also Connell *et al.*, 1960).

SUMMARY

Three patterns of fat deposition in relation to migration are now evident: (1) short-range migrants (*e.g.*, Savannah Sparrow) that become moderately obese but begin migration before peak deposition; (2) short-range migrants (*e.g.*, White-throated Sparrow) that begin migration after peak deposition; (3) long-range migrants (*e.g.*, Scarlet Tanager prior to trans-Gulf flights) that become extremely obese (fat up to 50 per cent of body weight) just prior to long flights.

Measured lipid levels and estimated flight ranges are presented for samples of birds (totaling 853 individuals of 15 species) killed during nocturnal migration at a Gulf coast television tower located near Tallahassee, Florida, or collected from premigratory aggregations at inland localities (see Tables 1 and 2).

In general, species of tanagers, thrushes, and warblers, which are now considered to be trans-Gulf migrants, proved to have more than enough fat to make the overwater journey nonstop (estimated flight ranges 1,000-2,500 km or 600-1,500 miles). The Indigo Bunting was an exception; most individuals in the fall sample did not have enough stored energy for a flight from West Florida to Yucatan. The difference between fall and spring Summer Tanagers and Hooded Warblers indicated a northward flight of about 1,000-1,300 km (600-850 miles) for these species, which would account for a trans-Gulf flight. Furthermore, spring specimens killed at the Gulf coast tower still had ample fat to account for the "coastal hiatus" as well. Likewise, fat levels in swifts and hummingbirds at inland localities in the fall indicate that these species could begin a fall trans-Gulf flight from points several hundred miles inland from the Gulf coast.

The possibility of distinguishing between Florida-West Indian and trans-Gulf migrants on the basis of lipid levels is discussed. Bird students are urged to take weights and wing measurements on specimens killed at television towers, as well as birds captured for banding, since good estimates of fat and flight range can eventually be made on the basis of these two easily taken measurements.

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ESOPHAGEAL DIVERTICULA IN THE REDPOLL, *ACANTHIS FLAMMEA*

HARVEY I. FISHER AND ELEANOR E. DATER

ON 16 March 1960 the junior author banded a Redpoll that had an unusual enlargement on the right side of the neck (Figure 1). Closer examination revealed a similar enlargement on the left side. Finally it was determined that both enlargements were a single pouch filled with millet seeds. More than 600 Redpolls were subsequently banded, and each showed similar dilations.

When filled with seeds, this enlarged esophageal pouch is visible externally in the lateral cervical apterium on either side of the neck (Figures 2 and 3). In dorsal view the impression of separate lateral pouches is enhanced by the fact that the cervical portion of the dorsal spinal tract of feathers divides the enlargement superficially. In the two specimens at hand the pouch is 12 and 15 mm long on the left side, and 16 and 19 mm in length on the right side; size of course depends upon the volume of the contents. The portion on the right side occupies

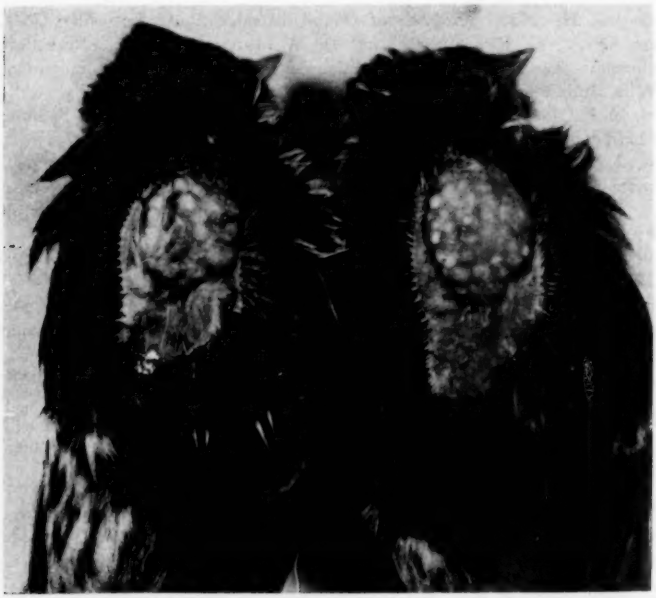

Figure 1. Superficial external view of right side of esophageal pouch in Redpoll. No dissection.

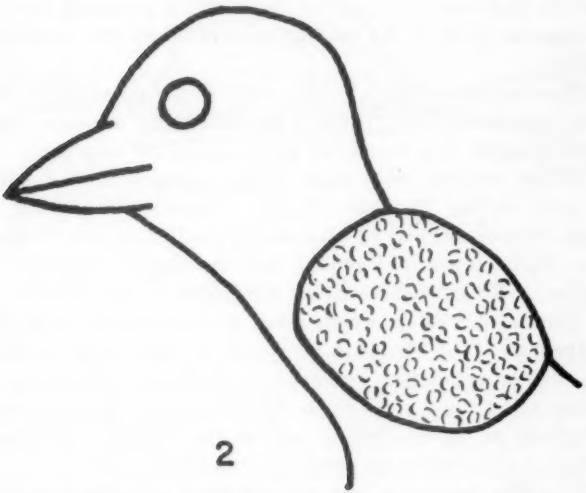

Figure 2. Diagram of left side of esophageal pouch in Redpoll.

the entire length of the neck from the posterior end of the skull to the sternum.

Dissection shows that there is actually a single enlargement of the esophagus (Figure 5), which extends laterally and dorsally around the right side of the vertebral column and forms a lesser enlargement on the left side of the column (Figure 4). The slight dorsal constriction

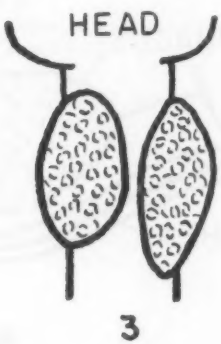

Figure 3. Dorsal view showing superficial division of esophageal pouch into right and left components.

between the right and left parts of the pouch is produced by a pair of dermal muscles lying in the midline, as well as by the feathers of the spinal tract.

The diverticulum is thus a "false crop" in the terminology of Pernkopf and Lehner (1937). There is no controllable aperture between it and the esophagus; it is simply an expansion of the esophagus.

Microscopic sections were made of the enlargement in the Redpoll, of the crop in the Domestic Pigeon *(Columba livia)*, and of the esophagus in the Cardinal *(Richmondena cardinalis)*, the Rufous-sided Towhee *(Pipilo erythrophthalmus)*, and the English Sparrow *(Passer domesticus)*. No unusual situation was found in the Redpoll. Simple tubular glands, such as apparently occur in many species, were found in the epithelium. The glands were ovoid in shape and farther apart than in the other species examined, and the cornified layer of the epithelium was thinner. All these differences may have resulted from the stretching of the esophageal wall in the Redpoll; preservation in formalin took place when the pouch was filled with seed.

Such croplike structures are not unknown in other species. The junior author has found them in the Goldfinch *(Spinus tristis)* in late November. Dr. Finn Salomonsen (pers. comm.) indicated that he had observed them "even in summer" in the Redpoll and was "astonished" by their size. Niethammer (1933) reported that filling of the fusiform crop in *Passer, Serinus,* and *Loxia* caused a dorsal and lateral expansion. Eber (1956) found that the full crop in *Chloris chloris* may extend dorsally over the vertebral column; Farner (1960:419) indicated the same condition in *Poephila guttata*.

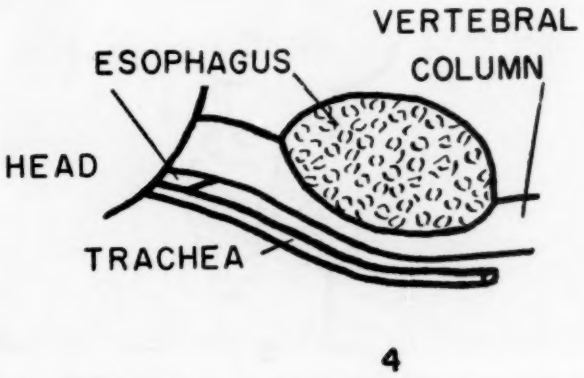

Figure 4. View of left side showing relationships between pouch, vertebral column, and trachea.

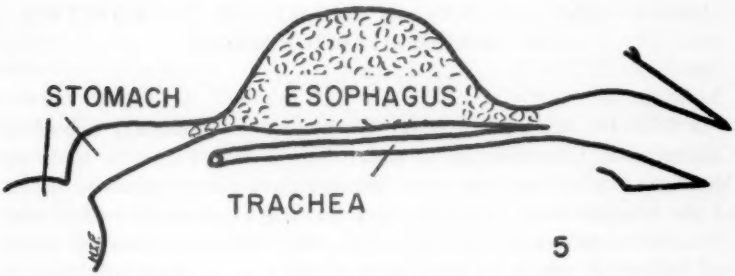

Figure 5. View of right side of esophageal pouch.

It is interesting to speculate on the function of this unique expansion of the esophagus. Its use as a storage place for food can be assumed. But why is it so extensive, and why the dorsal, subdermal extension to the opposite side of the neck? Why would not a crop in the usual position perform just as well? The amount of food contained in the expanded esophagus of these Redpolls seems relatively great—much more than is usually contained in the crop of a bird of similar body size. Is it possible that flexion of the neck in feeding would be impeded if this mass of food were contained in a ventrally located crop?

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FOOD CONSUMPTION IN RELATION TO HABITAT IN BREEDING CHICKADEES

H. N. Kluyver

In 1959 Dr. W. H. Drury, Jr., Director of the Hatheway School of Conservation Education at Drumlin Farm, invited me to come to Massachusetts to carry out some ornithological investigations in behalf of the Massachusetts Audubon Society. The Black-capped Chickadee *(Parus atricapillus)* was chosen for this study because it is easy to watch and because it would be possible to compare its biology with that of European tits, which I have studied for many years (Kluyver, 1950, 1951, 1952, 1957; Kluyver and Tinbergen, 1953).

Both European deciduous and coniferous woods are inhabited by tits (*Parus* species), and each species has a typical habitat. One species, the Great Tit *(Parus major)*, although mainly adapted to deciduous woods, will also inhabit pine woods, where insects suitable for its food (in spring mainly caterpillars, as these larvae are large enough for feeding nestlings) are relatively scarce. Moreover, in European pine woods the Great Tit meets serious food competition from other species of tits, whose methods of hunting insects are better adapted to pine-wood conditions. Pine wood is, therefore, a marginal habitat for this species, with reproduction being lower and mortality higher than in deciduous woods.

Because it is the only species of *Parus* in eastern Massachusetts, the Black-capped Chickadee does not meet with any competition from allied species and lives in both types of wood. Natural mixed woods probably are its favorite habitat, where it hunts insects in both broad-leaved trees and pines. It nests, at least in Massachusetts, primarily in dead birches. From my European experience I expected deciduous woods to contain more preferred food insects (both species and individuals) than pine. The object of my study was to investigate if and to what extent some of the factors that control population density—especially reproduction and nestling mortality—are influenced by the availability of caterpillars and other food resources. Moreover, I wanted to study details of nest building and breeding biology, as well as dispersal of adults and young in the postreproductive season.

Area of Study and Nesting Accommodation

My observations were made in the woods of Drumlin Farm, which includes nine hectares (22 acres) of pure pine woods [red pine *(Pinus resinosa)* and white pine *(Pinus strobus)*] and 22 hectares (55 acres)

of mixed wood, the latter consisting of a mixture of pines, oaks, and birches (gray, yellow, and black), with some ashes, maples, and hickories. This mixed wood consists of a canopy of high trees as well as an understory of bushes and dense deciduous scrub with scattered pines. Pure deciduous wood (mainly oaks) of an area of about 0.6 hectares (1.5 acres) was to be found on only one place. On Drumlin Farm 77 boxes suitable for chickadees were available. In the course of the preceding winter Dr. Drury put up an additional 24 boxes in a nearby oak wood. He also filled all of the boxes with wood chips and peat dust in order to meet the instinctive drive of the chickadees to dig a hole in soft wood. On Drumlin Farm this arrangement proved to be successful, 25 boxes being occupied by chickadees. In the oak wood, however, none of the 24 boxes were accepted. The reason may have been that all dead trees have been removed on Drumlin Farm, and that natural nesting accommodations are scarce. In the oak wood, dead birches were common, and the chickadees, which probably were not less numerous in the latter wood than on Drumlin Farm, used the natural nesting sites, which they had to dig out themselves. None of the boxes were excavated, and this suggests that the birds did not "find" these boxes. Indeed, some nests were found in natural cavities. The latter broods, however, were not included in my study, as I feared I would disturb the nests by cutting into the walls of the holes.[1] Moreover, the nests in the oak wood were rather remote, and it would have taken much time and energy to include them in a regular comparative study. Because one nest was situated in a small pure oak wood on Drumlin Farm (nest box 113), I decided to study this brood intensively, and to eliminate the broods in natural holes in the large oak wood. Later I regretted having done so, as the parents of box 113 were extremely shy birds and, moreover, took a large amount of the food for their nestlings not from oaks but from more distant white pines. This was one of the reasons why I could not wholly carry out my projected study.

All nest boxes were either made of birch logs or were standard boxes covered with birch bark in order to meet the supposed preference of chickadees to nest in birches. I think this arrangement has fostered their success on Drumlin Farm. Seventeen of 77 boxes on Drumlin Farm were made of cut lumber with a rectangular cavity of 55 to 70 cm^2, and 60 were logs with a circular area of 25 to 32 cm^2. Two (12 per cent) of the 17 rectangular boxes were occupied by chickadees; and

[1] This fear may have been unfounded as I learned in the course of the season that chickadees tolerate much more interference at their nesting sites than most European tits do.

21 (35 per cent) of the 60 logs. These figures may indicate a preference for a circular breeding hole, or preference for the round log rather than the square box. Moreover, the cavity of the square boxes appeared to be too large, which led to poorer breeding results in one of them. Two of the log cavities were widened when the chickadees cut out a part of the back wall of the log before nest building was started. This action does not indicate that the original cavities were too small, for the birds only removed a part of the wall above the bottom and did not widen the nesting cavity. I think this action was merely a consequence of the birds' instinctive drive to cut a hole in soft wood. The entrance of most of the logs measured 3 to 3½ cm, and the depth of the underlying cavity was 12 to 15 cm. All of the chickadee boxes were checked once in seven to 12 days.

EGG LAYING

The chickadees began egg laying in the last week of April, seven out of 20 pairs having begun before or on 28 April. At that time a laying pause set in, which I attribute to a cold spell that began on 27 April and ended on 1 May. As a consequence of this, only two pairs started their brood between 28 April and 5 May. Four days after the cold spell had ended, a new group of broods was started. An analogous influence of a cold spell setting in after the start of the laying season is often observed in European tits, which also show a delayed reaction of some days. As in chickadees, the tits that had started before the cold spell did not interrupt their laying action, but laid an egg every day as usual.

Laying season closed with one second brood, the first egg of which was laid on 8 June.

During the laying period the female is on the nest at night. She usually lays one egg a day, early in the morning, before she leaves the nest for the first time. During this period she leaves the nest half an hour later than usual.

Twice I established an exception to the rule that an egg is laid every day early in the morning. The female of box 26 laid her first egg in the late afternoon or evening of 1 May, and her second egg the next morning. This exception might be connected with the general delay of laying as a consequence of the above-mentioned cold spell.

The female of box 27 missed a day in laying. The box contained one egg on 10 May. The next day I observed the behavior of the pair in question in the early morning. At the usual time of 0504 the male started its *pheebee* song. In an unusual action the female now immediately left the box. Later I checked the box and found that no egg had been laid. The next morning the female again laid an egg.

CLUTCH SIZE

Among 25 broods, one clutch contained eight eggs, 14 clutches had seven eggs, eight clutches had six eggs, and the size of two clutches remained unknown. Clutches of six eggs were laid all through the season; the two last clutches, which started in early June, also contained this number of eggs. Clutches of seven were not laid after mid-May. The only clutch of eight eggs started on 28 April, with laying continuing throughout the cold spell. This suggests that the cold weather, though delaying the start of clutches, did not decrease the size of the clutches that had started before the weather turned cold.

The mean clutch size was 7.0 for the period to 28 April (7 broods), 6.6 for the period between 1 May and 10 May (11 broods), and 6.4 for the later five broods.

Any influence of habitat (deciduous or pine wood) or winter feeding on start of breeding or size of clutch could not be established, though such an influence might exist.

INCUBATION

Because some Black-capped Chickadee males showed indications of a brood patch, I originally thought that the species might differ from European tits, where incubation is the exclusive duty of the female. I must agree with Odum, however, that there is no evidence that the male takes any part in incubation. I always found the female incubating, though the male regularly comes to the nest to feed the female, either inside or outside the hole.

Incubation period (number of days between laying of last egg and hatching of eggs) was usually 12-13 days, which is the normal period in song birds. In one case I observed a prolonged incubation period (15 days), which must have been due to the fact that the female was not able to incubate in the usual way. It had built a nest in a large, rectangular box (area of bottom, 70 cm^2) so that her loosely built moss nest had little support. During incubation the nesting cup steadily enlarged, and the eggs landed on the horizontal wooden bottom of the box, where they lay more or less scattered most of the time. Three of the seven eggs did hatch, but only after two days longer than usual.

The rhythmic behavior of the female during incubation, involving periods on and off the eggs, was studied in one brood (box 106, second brood). Observations covered 30 hours and were spread over three days. The average lengths of the periods spent on the eggs on those three days were 23 minutes, 27 minutes, and 18 minutes,

respectively. Variability of on-periods ranged from seven to 47 minutes; periods of more than 35 minutes were rare, however. The female is often called off the eggs by the male, who intends to feed her, sometimes in the nesting cavity, but sometimes outside.

Average time off the eggs amounted to eight, seven, and eight minutes on the three days of my study, with the extremes being two and 17 minutes. During these periods the female often begs for food from the male. He feeds her at intervals, and in the meantime she also feeds herself.

NESTING SUCCESS

In the breeding season of 1959 the boxes contained 25 broods, eight (32 per cent) of which failed completely. House Wrens were the main predators and pilfered the eggs of five broods (20 per cent). The nestlings of one brood died with rachitis; an unknown predator took the newly hatched young of another brood; and in one brood all of the young died, one after another, of an unknown cause. No broods were abandoned because of death of parents, nor as a consequence of my frequent interference. The latter was due much more, however, to the faithfulness with which parent chickadees take care of their broods than to my own cautiousness. The birds endure much more interference at their broods than do most European tits.

The 17 successful broods consisted of five completely successful broods, where all of the eggs resulted in young leaving the nest, and 12 partly successful. Successful nests had 113 eggs. Ninety-six of these hatched; and of these, 11 young died in the nest and 85 nestlings fledged. Thus 75 per cent of the eggs laid in successful nests, and 51 per cent of eggs laid in both successful and unsuccessful nests, resulted in fledged nestlings. Nestling mortality (12 per cent of eggs hatched) was consequently very low. It is much lower than the analogous figure in European Great Tits in pine wood, and about equal to that of this bird in its most suitable habitat, the oak wood. As the Drumlin Farm chickadees collected the bulk of their food in pines, they are obviously very well adapted to this habitat.

In two broods (boxes 209 and 214) rachitis caused the death of all, or a part of, the young. This illness shows itself in poor development of legs and wings, and flexibility of tarsi. Moreover, body weights fell behind those usual for young chickadees. Rachitis is known to cause the death of nestling European tits in sandy regions poor in lime. On Drumlin Farm rachitis was also found on a sandy place. In box 209 all of the seven young died between the 10th and 18th

day after hatching. In box 214 nestlings showed a remarkable recovery and left the nest of June 16 at an age of 20 days, which is two to three days later than usual. One of these birds was observed in good health near box 23 on 27 July.

GROWTH OF NESTLINGS

I paid special attention to growth of nestlings, since the principal problem of my investigation was the influence that food supply available to parents for their nestlings exerts on nesting success.

Fledging periods were observed accurately in 11 nests: two of 16 days, four of 18 days, three of 19 days, and two of 20 days.

Data on growth of nestlings are presented in Table 1. Nestlings weigh about one g at hatching time, and weight increases regularly in the course of 12 days to 10-11 g. After that age weights increase little, the average at 15 days being 11.3 g, which is close to the weight of adults. The average of 16 adult chickadees weighed at Drumlin Farm in May 1959 by Carl Helms was 12.2 g (extremes 11.0 and 14.1 g).

No significant weight differences of nestlings could be found in

TABLE 1

GROWTH OF NESTLING CHICKADEES, DRUMLIN FARM, 1959

(Averages of weights in g)

Age	*First brood* *Number of nestlings*								*Second brood* *Number of nestlings*				
	3n *Box 26*	*3n* *Box 217*	*5n* *Box 113*	*6n* *Box 16*	*6n* *Box 203*	*7n* *Box 21*	*7n* *Box 105*	*All broods*	*3n* *Box 106*	*5n* *Box 204*	*5n* *Box 204*	*5n* *Box 204*	*All broods*
0									0.9				0.9
1			1.4					1.4			1.8		1.8
2							2.2	2.2	1.7			2.6	2.2
3			3.3					3.3		3.6	3.2		3.4
4												3.7	3.7
5			5.4				5.6	5.5	3.7	5.6	5.0		4.8
6	7.1	7.0			6.9			7.0				5.8	5.8
7			6.9				7.4	7.2	6.6	7.9	7.4		7.3
8				8.6				8.6	8.2			7.6	7.9
9			8.8		10.2		8.9	9.3		9.7			9.7
10		9.8				9.1		9.5					
11	10.7		10.2				9.6	10.2			8.3		8.3
12					11.5			11.5				9.0	9.0
13			11.0			10.2	10.2	10.5		10.4			10.4
14				11.1				11.1					
15							11.3	11.3					

early and late broods, nor between broods situated in deciduous (box 113) and pine wood (box 105).

KINDS AND WEIGHTS OF PREY

For studying I made use of three methods, each of which, however, was barely successful. Nevertheless, they provided an insight in the kind of prey that the parents collected. The methods consisted of: (1) Observations with binoculars. Larger prey, such as large caterpillars, sometimes can be recognized; smaller prey, however, hardly ever. (2) Observations from a blind. This method yields more success, but very often parents fly so rapidly into the box that no prey can be recognized. (3) Taking samples by closing the esophagus of nestlings with a metal collar gave little success, as most nestlings wearing such a collar refused to beg for food. The few samples collected were weighed, however, and gave a reliable basis for the estimation of weights of prey observed from the blind.

I recognized 65 prey items which, in a superficial way, can be classified as follows: 35 caterpillars (13 large and 22 small), 11 spiders, 6 small unidentified larvae, 4 small red larvae, 6 termites, 1 white butterfly or moth, 1 pupa, 1 fly.

Weights of these items may be estimated as follows: large, green caterpillars averaged at the end of May and in early June 200 mg and at the end of June 300 mg; smaller caterpillars, 120 mg; spiders, 70 mg; 6 termites all together that were fed in one parcel, 50 mg.

Because caterpillars were, on the average, three times as heavy as the average of all other prey, the bulk of nestling food doubtless consisted of the former insect larvae.

Average weight of feedings turned out to differ considerably in different broods.

In nest box 16 (orchard) I estimated average weight of prey items as 70 mg. This very low average might be due to the early season of this brood, which was the first to hatch.

In boxes 105 and 106 (first and second brood of the same pair in pine wood) many big, green caterpillars were fed. Average weight of food items may be estimated at 120 mg in the former and 180 mg in the latter brood.

In box 204 (late brood in pines) prey items were small, average of 35 preys being estimated at 90 mg. The small average prey size of this brood was the more remarkable as big caterpillars were by no means scarce in close vicinity of this nest, as was shown by an incidental sample of caterpillar droppings.

Tinbergen (1960) showed that European tits often develop a specialization for hunting in a certain microhabitat and adhere tenaciously to it, even when other microhabitats in the meantime have developed better food resources. It might be that we have to seek along this line to find the explanation of why the parents of box 204 did not collect many green caterpillars.

NUMBER OF FEEDINGS AND DURATION OF ACTIVITY

The number of times the parents entered the nest box (which is practically equal to the number of feedings, as parents rarely enter without bringing food) was mechanically recorded with two chronographs (see Figure 1 for contact apparatus) in five broods.

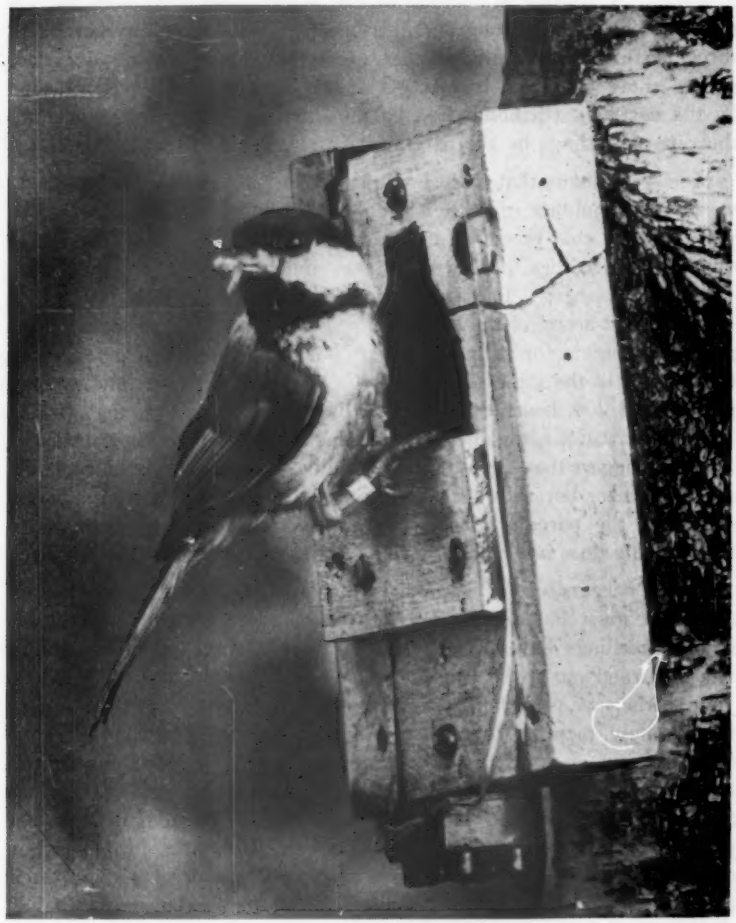

Figure 1. Chickadee with food for nestlings at nest box with contact apparatus. Entering parent moves hanging strip and makes chronograph operate.

In order to study the influence of different habitats and different brood sizes on feeding activity, I calculated the daily number of feedings per nestling present in every box. Table 2 clearly shows large differences in number of feedings per nestling in different broods. The presence of many fellow nestlings, however, does not appear to exert any influence on the number of feedings that every nestling gets in a day. A nestling in a brood of five young (box 113) does not get more feedings than a congener in a brood of six. Even in a brood of three nestlings, the daily number of feedings per nestling does not exceed those of larger broods. This suggests that the need of food by the nestlings (demonstrated by the intensity of begging) regulates the rate of feedings by the parents.

Most prey items that were brought by the pair of box 16 (orchard) were small; number of feedings, on the other hand, turned out to be very large in this brood. In the brood of box 105 (pine wood) the number of feedings per nestling was much smaller, but prey size considerably larger. The same holds for the brood in box 106, which was a second brood of the same pair. This pair mainly collected large, green caterpillars for their nestlings. Number of feedings per nestling in box 204, in the same season as 106, was much higher. The average prey size of 204, however, might hardly amount to half of that of 106. These observations, together with the facts in the preceding paragraph, strongly suggest that the number of feedings per nestling is independent of brood size, but shows close correlation to the average size of the prey that the parents collect. Obviously, the need of nestlings for food usually does not reach a level that the parents are unable to meet.

If the parents usually do not work at the utmost level of their ability, it must be possible for them to accelerate their feeding pace in case nestlings have become hungry after a space of fasting. This indeed turned out to be possible in box 204 on two days (29 and 30 June), when we were taking a series of photographs. Preparations for taking these pictures interfered with the regular course of parental feedings, and on both days feedings were nearly stopped for several hours in the morning. From 1500 to 2000, however, the parents accelerated their pace to 118 on 29 June and 86 on 30 June. In the preceding days this pace had amounted to 47 only. Moreover, on each of the days on which pictures were made the parents ended their activity half an hour later than usual. And they even started it half an hour earlier than usual each day following a picture day, thus having a short night's rest. This extending of working hours proves that parents usually do not work as long as possible. In addition, it sug-

TABLE 2

NUMBER OF ENTRANCES (FEEDINGS) PER DAY

Box 16, 6 young			*Box 105, 6 young*			*Box 113, 5 young*			*Box 204, 5 young*			*Box 106, 3 young*		
Date	*Age*	*Feed p.y.*	*Date*	*Age*	*Feed p.y.*	*Date*	*Age*	*Feed p.y.*	*Date*	*Age*	*Feed p.y.*	*Date*	*Age*	*Feed p.y.*
V- 16	3	48	V- 21	2	22	V- 27	4	21	VI- 20	1	29	VI- 25	1	14
17	4	44	22	3	24	28	5	24	21	2	27	26	2	19
18	5	52	23	4	25	29	6	24	22	3	27	27	3	23
19	6	45	24	5	28	30	7	(23)	23	4	33	28	4	21
20	7	49	25	6	30	31	8	(25)	24	5	36	29	5	(25)
21	8	44	26	7	27	VI- 1	9	26	25	6	35	30	6	(30)
22	9	43	27	8	24	2	10	23	26	7	40	VII- 1	7	33
23	10	(51)	28	9	(24)	3	11	30	27	8	42			
24	11	59	29	10	(24)	4	12	31	28	9	42			
25	12	67	30	11	24	5	13	33	29	10	48			
			31	12	29	6	14	30	30	11	41			
			VI- 1	13	31	7	15	36	VII- 1	12	47			
			2	14	32	8	16	33						
						9	17	32						
						10	18	30						
						11	19	23						

Numbers in parentheses are estimates based on incomplete recordings.

gests that they might have worked at top capacity in the afternoons of the days pictures were taken.

Daily number of feedings usually increases later in the nestling period, thus meeting the increasing need of food of the growing young. In European tits I have often seen the same trend.

Table 3 shows that in box 106 the incubating female arose very late (average of 86 minutes after sunrise) and retired very early (60 minutes before sunset). During the nestling period, when feeding the nestlings is the parents' main duty, the beginning of daily activity is much earlier and the end much later in all broods. Nevertheless, feeding activity usually does not start before sunrise, and in most of the broods starts some 10-20 minutes later than that. This is considerably later than the usual start of the male's song in the prenesting period, which again shows that the birds do not need the whole of their day for their feeding duty.

The parents cease feeding from five to 20 minutes before sunset. The female now ends all of her activity as she broods the nestlings

TABLE 3

AVERAGE AND EXTREMES (IN MINUTES) OF BEGINNING OF PARENTAL ACTIVITY AFTER SUNRISE AND END OF IT BEFORE SUNSET

Box Stage Season	*Beginning after sunrise*	*End before sunset*
16 nestl. 15-25 May	−1 (extr. 8 aft. and 21 bef.)	22 (extr. 44 bef. and 1 aft.)
105 nestl. 21 May-3 June	14 (extr. 29 aft. and 6 bef.)	7 (extr. 27 bef. and 29 aft.)
113 nestl. 27 May-11 June	6 (extr. 13 aft. and 7 bef.)	5 (extr. 42 bef. and 22 aft.)
106 incub. 16-24 June	86 (extr. 102 aft and 66 aft.)	60 (extr. 77 bef. and 49 bef.)
106 nestl. 25 June- 2 July	18 (extr. 26 aft. and 8 aft.)	28 (extr. 38 bef. and 7 bef.)
204 nestl. 19 June-1 July	23 (extr. 41 aft. and 4 aft.)	25 (extr. 49 bef. and 21 aft.)

at night. The male, however, remains active for some time. The end of feeding activity may depend not only upon the need of the nestlings for food, but also upon weather conditions. Sometimes a heavy rain shower caused an early end to the activity of the parents.

HABITAT PREFERENCE OF CHICKADEES AND NUMBERS OF INSECTS

Our observations showed that caterpillars [larvae of butterflies and moths *(Lepidoptera)* and sawflies *(Tenthredinidae)*] were the main items of prey fed to nestlings and fledglings.

I tried to determine the relative abundance of caterpillars by comparing the numbers of fecal pellets dropped from the canopy and caught on horizontal screens with those samples from other areas. Caterpillar pellets are of a characteristic shape and very resistant to weather. They do not disintegrate in the rain, nor when dried. Screens were put up on 20 May, *viz.:* five screens under red pine, five screens under oak, two screens under ash, and, from 1 July onward, two screens under white pine. Pellets were collected each week in paper sacs, and dried. After removing coarse dirt, such as conifer needles, etc., the whole sample was weighed. Then we counted the number of pellets in a part of the sample. The total number of pellets per screen was approximately calculated in this way.

Our screens were 50 x 50 cm each. One might wonder if the numbers of pellets that drop onto from two to five screens of this dimension have to be considered as a random sample for a section of woods. Do we not need a greater number of screens? The answer to this question depends on the uniformity of dispersion of the caterpillars in the wood. This uniformity can be established by studying the variability in the numbers of pellets found in the various screens. On Drumlin Farm I did not study this question in detail, but Tinbergen (1960) had done so in his extensive study of the dynamics of insect and bird populations in Dutch pine woods. I only established the fact that the numbers of droppings that I caught in the screens in a certain wood area did not vary a great deal. For this reason I have the impression that the averages give a fairly good comparative measure for pellet fall in the whole area.

Table 4 shows that pellet fall was subject to great variability in the course of the season of my study. In both pines and oaks pellet fall was high in late May and early June. After that it decreased, and then increased again in early July. It decreased again in mid-July. In red pines it reached a maximum in the last 10 days of July. In oaks, however, it steadily increased between mid-July and mid-August.

Pellet fall might be influenced by feeding activity as well as by the simple presence of caterpillars. Generally, activity of insects is primarily influenced by air temperature. A detailed study of the influence of temperature on pellet fall requires a study of the caterpillar species that produced the pellets. In general, it must be possible to identify a caterpillar and its instar by examination of its pellets. I had to give up this identification as my knowledge of American insect species is insufficient, and I confined my studies to a determination of the total number of pellets.

Table 4 shows that in two periods in June and August, when temperature was low, pellet fall in red pines and oaks was also low. The same holds with ash trees. The drop in red pines and oaks in mid-July, however, was doubtless not caused by a fall of temperature; and in oaks the upward trend of pellet fall in August continued during a temperature drop. Thus, these observations do not show a clear correlation between pellet fall and air temperature.

Pellet fall must be primarily connected with numbers of caterpillars. The fluctuations of pellet fall in red pines and oaks (cf. Table 4) must be primarily due to the numbers of various caterpillar species, which followed one another in attacking the needles and leaves in the course of the season. Sizes and rates of growth of these various caterpillars, and consequently their pellet productions, are unequal. Nevertheless, in my opinion, pellet fall gives a fairly good, though crude, comparative measure of the numbers of caterpillars in various kinds of trees.

Do the numbers of falling pellets give us a good relative measure of the amount of food available for the chickadees in the trees concerned?

In the discussion of "Kinds of Weights of Prey" it was shown that nestling chickadees on Drumlin Farm were mainly fed with caterpillars. Chickadees show a clear preference for larger food items, especially with respect to the prey that they feed their young. In feeding nestlings, most pairs rarely make use of food items of less than 8 mm. Therefore, they are not interested in the first instars of most caterpillars, and I did not count pellets smaller than 1 mm.

TABLE 4

AVERAGE NUMBER OF FECAL PELLETS OF CATERPILLARS FOUND PER DAY IN GROUND SCREENS OF 2500 CM.^{2} UNDER SEVERAL TREES

(Air temperatures are calculated from mean daily air temperatures at Drumlin Farm B station)

Period	*Mean air temp. F.*	*Red pine*	*White pine*	*Oak*	*Ash*	*Ratio oak/red pine*
20-27 May	62	14	—	33	10	2.4
28 May-8 June	62	87	—	64	21	0.7
9-12 June	65	64	—	28	8	0.4
13-22 June	56	36	—	9	3	0.2
23 June-1 July	64	40	—	15	10	0.4
2-9 July	65	75	472	30	38	0.4
10-17 July	68	35	141	17	100	0.5
18-24 July	72	69	48	25	82	0.3
25 July-1 Aug.	70	122	81	39	144	0.3
2-8 Aug.	62	56	52	56	61	1.0
9-16 Aug.	71	60	136	72	67	1.2

In addition to caterpillars, other arthropods, such as spiders, which do not produce measurable numbers of fecal pellets, were important food. Moreover, chickadees doubtless do not take the same toll of all caterpillar species. Well-camouflaged caterpillars run less risk of being eaten than do more conspicuous ones.

In spite of these objections it seemed useful to investigate the correlation between the places of high pellet fall with those where chickadees were found feeding.

On the basis of my study of pellet fall, caterpillars were more numerous at the end of May in oaks than in red pines; but from early June to the end of July they were less numerous in the oaks (see Table 4). In the first half of August they were nearly as numerous in both habitats. In May caterpillars were less numerous in ash trees than in oaks, but in July their numbers increased considerably and for some weeks even surpassed those in oaks and red pines.

I expected that it would be easy to compare these observations of abundance of food with those in places where the chickadees collected food for nestlings. Establishment of the latter places, however, turned out to be more difficult than I expected. I often lost the feeding parents from sight as soon as they left their nest. As they were silent during the nestling period, it was usually impossible to find them again in the canopy. If a box is placed at the border of two types of vegetation, it may be that the direction that the leaving birds take suggests the preferred habitat. In two such cases the birds chose mainly red and white pines. The parents of box 16, which was situated in an orchard, did not collect any food in the fruit trees around their nesting site. This might be due to the fact that the trees were regularly sprayed with insecticides and contained hardly any caterpillars. The parents mainly flew to a nearby small red pine wood. In back of these woods, however, was an unsprayed orchard, and sometimes the birds extended their food excursions there. In box 113 the situation was the same. This box was situated in a small, deciduous wood, with a white pine wood on one side. But I rarely succeeded in establishing whether food was collected in the deciduous or in the pine wood.

Localization of the place of collection of food is much easier shortly after the fledglings have left the nest. The families wander through the woods and make themselves conspicuous by the call notes of the parents, and the begging notes of the young. A tenacious observer often sees the parents picking up prey and bringing it to their young.

After the family parties have disintegrated, adults and juveniles mingle in mixed flocks. I observed these "summer flocks" (which might be identical with "winter flocks") from mid-July onward. These flocks were less noisy than the family parties, but nevertheless they are easy to locate by the faint *"seep"* contact notes that the birds incessantly utter.

My observations indicate that family parties and summer flocks concentrated in groves of trees, where caterpillars proved to be abundant. From 3 June onward, *i.e.*, the very first date at which young left the nest site, the families had a marked preference for certain parts of the sanctuary—clumps of red and white pines. If on their journeys the birds passed oak woods, they did not avoid them, but rarely stayed longer than from five to 10 minutes (exceptionally 20 minutes). In pines, however, they often stayed several hours. Until the end of June the families almost exclusively stayed in red pines, which coincided with the abundance of caterpillars in the latter trees as compared with oaks (see Table 4). From the first of July onward the chickadees switched over to the white pines. As I had no screens under white pines, I placed them the next day. Indeed pellet fall showed that caterpillars were extremely abundant, though the bulk of them must have been small in size. Their numbers rapidly decreased. Around 20 July pellet fall under white pines had gone down below the level of that under red pines. Indeed, the chickadees changed over to the latter trees at about this time.

Two screens were under ash. Pellet fall under ash trees was rather low until July but considerably increased during this month and remained rather high until mid-August. I couldn't observe, however, any concentration of chickadees in ash trees during this time, probably because ash trees are scarce and scattered on Drumlin Farm.

These observations show that after the breeding season chickadees assemble and collect food in places where food is most abundant. (Analogous behavior is well known from winter time, when food is scarcer than in summer and concentration on places rich in food, so-called feeding tables, is much more evident.)

I failed to find any influence of the amount of food present in the habitat on the reproductive functions of the chickadees. For such an investigation various kinds of vegetation proved to be too much intermingled on Drumlin Farm, parcels of pines being in succession with oaks, birches, ash, and other trees. The planned observations in a nearly pure deciduous wood of oaks and birches had to be cancelled as the birds did not occupy the boxes in that wood.

POPULATION TRENDS

During the breeding season I put my best efforts into trapping all of the breeding birds, especially in the periods when they were feeding nestlings. Twenty-five broods in the boxes were undertaken by 45 different parents. One pair undertook a second brood, another pair

started a repeat brood in the same box where its former brood had been shortly disrupted by a House Wren, and one female undertook a repeat brood in a nearby box with change of male.

The 45 different birds present consisted of 14 that had been banded before (for the most part in fall and winter) on Drumlin Farm, 25 that were unbanded, and six of unknown banding status. I never observed the latter birds, either because their broods were disturbed in an early state or because one individual bird was very shy. Of the 25 unbanded breeding birds, 21 were trapped and banded, the brood was disturbed before I could trap two of them, and two were too shy to be trapped. All of the three shy birds must have been males.

As soon as the young become independent, family parties disintegrate. Many of the adults leave their spring territories, and all of the young leave the places where they were hatched. Now flocks of from five to 10 birds are formed. These flocks consist of both adults and young. I feel certain that very few or no young stayed in the immediate vicinity of their birthplaces. After the parents stopped feeding their young, *i.e.*, from 10 to 25 days after the latter had left the nest, I did not observe any of the 80 color-banded young close to their birthplaces, and only four at a greater distance. Many young must have left Drumlin Farm shortly after they became independent. The large number of unbanded young that appeared on Drumlin Farm in July and August (80 per cent of the 245 observations that I made closely were unbanded) is also evidence of the quick separation and movement of the young. Some adults stay at their breeding places, but they also temporarily join the flocks that wander through their ranges. Family groups, as Odum rightly points out, do not form the basis of the flock. Flocking develops rapidly during July, and before the end of this month true "winter flocks," accompanied by a White-breasted Nuthatch *(Sitta carolinensis)* and a Downy Woodpecker *(Dendrocopos pubescens)*, are often seen.

Observations in July and August suggest that many adults enlarge their range shortly after the breeding season. Many parents, among which were those wearing plastic collars, and which surely could not have escaped my attention, were no longer observed after they had stopped feeding their young. As I cannot believe that all of these birds died immediately thereafter, they must have enlarged their ranges outside my area of study.

A study of the recoveries that I gathered from bandings undertaken by the Drumlin Farm staff in preceding years (1956-1958) shows a remarkable difference in recovery percentages for different years. Of

36 birds trapped for the first time and banded in the fall of 1956, nine specimens (25 per cent) were recaptured as breeding birds in 1959. Because two and one-half years had passed and because annual mortality is doubtless very high in the chickadee (in European tits it amounts to 50 per cent per annum in adult birds), this high percentage supports the assumption that the 1956 fall birds must have been, to a great extent, permanent residents.

In the fall of 1957, chickadees were very abundant, and 52 specimens were trapped for the first time and banded. I succeeded in recapturing only two (4 per cent), although the time span between banding and recovery was a year shorter than in the 1956 bandings. Consequently, a higher percentage of the 1957 than of the 1956 fall birds must have either died (if residential) or emigrated.

It is difficult to understand why the 1957 death rate would be so much higher than the rate for the still-present 1956 birds. The most probable cause of this difference in per cent of home recoveries is that many of the 1957 birds did not stay on Drumlin Farm but rapidly wandered off.

Of 17 chickadees banded in the fall of 1958, I recaptured seven specimens. Considering the fact that these birds were subject to mortality for only half a year, it might be presumed that their rate of residents was between those of 1956 and 1957.

It would undoubtedly be worthwhile to continue this banding investigation.

Poor (1946) and, more recently, Lawrence (1958) have directed attention to the phenomenon that chickadees, after being residential for several years, are sometimes suddenly struck with a drive that urges them to wander. Such eruptive movements were observed in the fall and winter of 1941-1942 (Poor, 1948) and 1951-1952 (Lawrence, 1958). At those periods chickadees appeared in unusual habitats. Many of the birds appearing at several places in the United States in such years must have immigrated from more northern regions, whereas home birds emigrated elsewhere. In Lawrence's study the latter phenomenon was shown by a sharp drop in home recoveries of wintering birds, after this number had been fairly stable for some years.

Such eruptive movements are well known in other northern birds and also occur in European tits at irregular intervals (Cramp, *et al.*, 1960). The bulk of these emigrated birds never return to their original places. Such movements probably occur after an unusually large production of young during the preceding breeding season or

after unusually cold and cloudy summers. In both cases an acute food shortage might cause the phenomenon.

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Miss I. LeMon and Mr. P. Ourusoff kindly helped me in field work, and the latter took the photograph used in Figure 1.

SUMMARY

This paper deals with a four-month study of the ecology of the Black-capped Chickadee in the woods of Drumlin Farm, South Lincoln, Massachusetts.

Twenty-five of 77 nestlogs were occupied by chickadees, boxes having been made especially suitable for these birds by filling them with wood chips and peat dust, thus meeting their instinctive drive of digging a hole in soft wood.

The shortest distance between two chickadee nests was 55 meters.

Among 25 broods, one clutch contained eight eggs; 14, seven eggs; eight clutches, six eggs; and the size of two clutches remained unknown. Average of clutch size decreased as the breeding season progressed.

Rhythmic behavior of the female during incubation was studied during three days; averages of periods on the eggs amounting to 18-27 minutes, of periods off the eggs to seven to eight minutes. The male feeds his incubating female at intervals.

Of 25 broods, eight failed completely, the eggs of five of them being pilfered by House Wrens.

The nestlings of one brood died of rachitis.

Seventeen successful broods had 113 eggs, 96 of which hatched, 11 young died in the nest and 85 nestlings fledged.

Nestlings weighed about one g at hatching. Weights increased regularly in the course of 12 days to 10-11 g. After that weights increased only slightly. Nestlings fledged at 16-20 days.

Caterpillars were the main food of nestlings, with spiders second in importance. The former weighed 120-300 mg each; the latter, about 70 mg each.

Numbers of feedings were 21-29 per day per young in the first days

after hatching and increased to 30-36 per day. In an early nest, where young were fed with small prey, numbers of feedings were considerably higher.

In feeding nestlings, parents usually do not work at the utmost capacity.

Relative abundance of caterpillars in various types of wood was measured by pellet fall.

Chickadees prefer to collect food where it can be easily obtained.

Parents stop feeding their young 10-25 days after the latter have left the nest.

Immediately after juveniles become independent, family parties disintegrate and juveniles spread over a large area.

In July and August many adults stay at their breeding places, but enlarge their ranges.

A study of my 1959 recoveries of chickadees banded on Drumlin Farm in preceding years showed a high recovery percentage (25 per cent) of 1956 bandings, and a very low one (4 per cent) of 1957 bandings.

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GRACE'S WARBLER IN MEXICO

ALLAN R. PHILLIPS AND J. DAN WEBSTER

GRACE'S Warbler *(Dendroica graciae* Baird) can probably claim the dubious distinction of being the least understood of all of the widespread North American wood warblers. It is a typical inhabitant, at all seasons, of pine woods, though scattered pines in oak or oak-juniper woodlands suffice locally for its requirements.

Virtually all standard ornithological works, up to and including the recent (1957) American Ornithologists' Union's *Check-list of North American Birds,* consider this species to have but two continental races, separated in the breeding season by nearly the whole of Mexico. The nominate race is said to breed south only as far as Sonora and Chihuahua, while *D. g. decora* Ridgway is supposed to reach Oaxaca, but no farther northwest. In contrast, Moore (in Miller *et al.,* 1957) states that *D. g. graciae* breeds south along the Sierra Madre Occidental to Nayarit, and also in the "Transverse Volcanic Province east to Mount Orizaba," western Vera Cruz.

Actually, neither of these concepts is correct. It is quite true that Grace's Warbler nests in most of the mountains of western Mexico, south to Michoacan; but farther east in the main body of the "Transverse Volcanic Province" it is only a rare winter visitant. Its breeding range, in these longitudes, is confined to pine forests fronting, or near, the Pacific coast. Thus, if a population really exists on Mount Orizaba, it can be connected with other populations only through Oaxaca, a state inhabited by another race.

We have not seen the material on which the Vera Cruz record is based, and can express no opinion on its validity. Otherwise, the range of the species is apparently more or less continuous along the mountains of western Mexico. The changes that occur from Arizona to Oaxaca are essentially clinal. Adequate series of specimens in fall plumage are at hand from Arizona, Nayarit, and Guerrero. Smaller numbers in fresh plumage from elsewhere serve to outline the ranges of the races, and show the desirability of recognizing by name the Nayarit birds. They may be known as

***Dendroica graciae yaegeri*, subsp. nov.**

Types. Holotype female, adult in fresh plumage, collected by Allan R. Phillips 18 August 1956 on Cerro San Juan, six km (3½ miles) west of the village of Jalisco, Nayarit, Mexico, number 4258 in collection of Allan R. Phillips, and on deposit at Instituto de Biología, Uni-

versidad Nacional Autónoma de México. Eight paratypes in collections of Lewis D. Yaeger (Nos. 389, 390, 468, 469, 482, 483) and Allan R. Phillips (Nos. 4215, 4254); all from Cerro San Juan, west and southwest of Tepic, Nayarit, 12 July to 18 August, 1955 and 1956.

Diagnosis. Similar to *D. g. graciae* Baird, but fresh plumages distinctly clearer grayish, less brownish, on dorsum; less brownish on posterior underparts; throat and breast a brighter, more orangish hue of yellow; adult males with black streaks of back usually narrower. Similar also to *D. g. ornata* Brodkorb, but less bluish on dorsum, the adult males paler and browner, females and immatures more brownish and olivaceous; posterior underparts more buffy; throat and breast a duller, more yellowish hue of orangish yellow; and black streaks of back narrower and fewer in adult males. In size intermediate between these two races: wing average smaller than *graciae* but larger than *ornata;* bill, in lateral aspect, more slender than the latter but slightly more robust than in *graciae.*

Distribution. Breeds, and at least partially resident, in the pine forests of southern Durango, western Zacatecas, western Jalisco, and Nayarit.

Measurements. Twenty-six males from above states, wing (chord) 62-69 (average 64.9) mm.

Twenty male *graciae* from southern Arizona, wing 64-70 (67.0).

Thirty-two male *ornata* from Guerrero, Oaxaca, and Chiapas, wing 57-65 (61.6).

Remarks. We take pleasure in dedicating this handsome bird to Lewis D. Yaeger, in recognition not only of his unfailing help and guidance in Nayarit, and of the fact that he collected the first specimens seen by us and the bulk of the fresh series available, but also of his assistance to Phillips in work in Arizona and Sonora.

Males of all races of this species differ from females by their broader, blacker streaking above and on the flanks and less brown coloration, as was pointed out by Ridgway (1902) for true *D. g. graciae.* Therefore, females of *D. g. graciae* differ from *yaegeri* more than do males; and most females may be distinguished even in summer. Many males appear indistinguishable in general coloration by April. Three late-October-to-January males from Nayarit are *yaegeri,* and probably are resident birds. A typical female *D. g. graciae* was taken on the breeding grounds of *yaegeri* in Nayarit, 21 February 1955, and so winter specimens require careful study.

The characters of *yaegeri* emphasize the importance of accurate determination of the age and sex of specimens collected. A large and

exceptionally heavily streaked female of *yaegeri* might easily be confused with a male of *graciae*, though even in this comparison *yaegeri* is apt to be a bit paler, grayer, or less tinged with chocolate-brown.

In view of revisionary studies to be published separately by Webster, we defer further discussion here. Specimens examined in the preparation of this paper are chiefly in the collections of Phillips, Yeager, and the California Academy of Sciences. A few others were seen in the collections of W. J. Sheffler; and of the Instituto de Biología, Universidad Nacional Autónoma de México; Minnesota Museum of Natural History; Southwestern Research Station, American Museum of Natural History; and Western Foundation of Vertebrate Zoology. To the authorities of these collections we express our appreciation. Collecting of specimens for this study was made possible by the Arizona Game and Fish Commission and the Departmento de Caza, Dirrección General Forestal y de Caza, México, D.F. Part of Webster's work was supported by a grant from the National Science Foundation.

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A REVISION OF GRACE'S WARBLER

J. Dan Webster

Grace's Warbler *(Dendroica graciae)* is one of the least known of North American parulids. The behavior, ecology, and nest, so far as known, were described by Bent (1953). The races were briefly reviewed by Griscom (1935), including a description of a new race, *remota,* from Nicaragua. Brodkorb (1940) described a new race, *ornata,* from Chiapas. Phillips and Webster (1961) have recently described an additional race from Nayarit.

My own investigations involved the collection of several specimens in Mexico, including 20 in fresh plumage in August and September of 1959, and the study of 354 museum skins, most of them on loan to the California Academy of Sciences. I want to thank Dr. Robert T. Orr for his help throughout this study. Drs. Alden H. Miller at the University of California and Robert H. Storer at the University of Michigan were courteously hospitable in the museums they curate. The following museums generously loaned me their Grace's Warblers: American Museum of Natural History, British Museum (Natural History), University of California Museum of Vertebrate Zoology, Dickey Collection of the University of California at Los Angeles, Carnegie Museum, Chicago Natural History Museum, Museum of Comparative Zoology of Harvard College, Instituto de Biología of the Universidad Nacional Autónoma de México, Louisiana State University Museum of Zoology, University of Michigan Museum of Zoology, Minnesota Museum of Natural History, Texas A. and M. University, and the United States National Museum. Allan R. Phillips and Lewis D. Yaeger loaned me all the Grace's Warblers from their personal collections. Financial support was received from the National Science Foundation, Grant G8703.

Range and Ecology

The breeding range of Grace's Warbler extends from southern Utah, southeastern Colorado, and western Texas south through western Mexico to the Isthmus of Tehuantepec and through Central America, from western Chiapas to northern Nicaragua. The winter range includes the breeding range from Nayarit and Michoacan south and also the Transvolcanic Range of central Mexico east to Volcan Popocateptl. A single record from Veracruz is given in the Mexican *Check-list* (Miller *et al.,* 1957) as "Breeding, May, K-d" [K-d = specimen in Moore Collection]. See map, Figure 1.

Within the vast range described above, Grace's Warbler inhabits only pine forest, and the pines of pine-oak woodland and forest. More precisely, the range may be stated as: Along the Pacific coastal slopes of Mexico, from Nayarit to western Chiapas, it is resident in humid yellow pine forests at middle elevations of 800-1,800 meters (2,500-5,500 feet). In the southwestern United States and the eastern flank of the Sierra Madre Occidental of Chihuahua, Sonora, Durango, and Zacatecas it breeds in arid Ponderosa Pine, Chihuahua Pine, or Apache Pine forest, and pine-oak woodland, at elevations of 1,800-2,700 meters (5,500 to 8,000 feet). In central Michoacan it is resident under conditions somewhat intermediate between those described in the two preceding sentences—humid pine forest or pine-oak woodland at 1,500-2,500 meters

Figure 1. Distribution of Grace's Warbler in North and Central America. Names indicate the subspecies. Narrow, solid lines delimit the ranges of the subspecies. Broad, solid lines mark international boundaries. Dashed lines mark state boundaries in Estados Unidos de México and the United States of America.

Each locality from which a breeding-season specimen was examined in the present study is marked by a solid dot. Each locality where there is a record in the literature is marked by a hollow dot. Each locality from which only a wintering or migrant specimen was examined in the present study is marked by a cross.

(4,500-7,500 feet). In British Honduras and the Caribbean coast of Nicaragua it is resident in humid coastal pine forest near sea level. In El Salvador, northwestern Nicaragua, southeastern Chiapas, Guatemala, and Honduras it occupies humid pine forests at middle elevations of 650-1,500 meters (2,000-4,500 feet). The predilection of Grace's Warbler for pines is extreme; only twice have I seen one land in an oak tree, and then it was nervous and not foraging. The preferred habitat seems to be a sparse stand of rather small pines, 5-10 meters high. However, I have seen them in closed-crown pine forests where the trees are 25 meters tall. Paynter (1957) saw a few Grace's Warblers in broadleaved trees in mixed pine-broadleaved woodland in Chiapas. His conclusion that pines are not required for the presence of the species is, to my mind, erroneous.

The absence of Grace's Warbler from eastern Mexico, and from the temperate and boreal high pine forests of Estado de Mexico, Oaxaca, and all of Central America is striking. Conversely, the Olive Warbler *(Peucedramus taeniatus)* is a common to abundant resident in these areas, but is absent from the low-elevation and middle-elevation pines of the Pacific slope of Mexico and all of Central America. (There is some sympatry at middle elevations in Chiapas, at least, for at El Fenix, Monserrate district [see Edwards and Lea, 1955], we found Grace's Warbler common but the Olive Warbler present in small numbers in humid pine forest at 1,550 meters.) In Michoacan, humid pine forest and pine-oak woodland at 2,330-2,660 meters near Patzcuaro and Morelia is inhabited by both species, with the Olive Warbler the more common. In southern Durango, both species are found in the more arid pine fasciation on the eastern flank of the Sierra Madre Occidental, but only the Olive Warbler along the crest of the range. A Grace's Warbler was recently taken in Sinaloa, the first from that state or from the more humid western slope of the Sierra Madre Occidental. An adult male in fresh plumage, it was collected 27 July 1961 by Bill R. Brinkley, in the lowest clump of pines along the Durango-Mazatlan highway, at 1,300 meters, one mile south of Potrerillo. I prepared the specimen, which is now in the Calif. Acad. Sci. In southern Arizona and northern Sonora (Marshall, 1955, and Phillips, pers. comm.) the two species are largely co-resident, though the Olive Warbler ranges somewhat higher. The range of Grace's Warbler extends considerably farther north than does that of the Olive Warbler, the latter not going beyond southeastern Arizona and southwestern New Mexico.

The preceding paragraph was based on my observations in Sinaloa, Durango, Zacatecas, Michoacan, Nayarit, Guerrero, Oaxaca, and

Chiapas. Also, it was supplemented by information on many specimen labels and the statements of Marshall (1956) for Arizona and Sonora, Dickey and Van Rossem (1937) for El Salvador, and T. R. Howell (pers. comm.) for Nicaragua.

On migration Grace's Warbler must, occasionally, land in stands of deciduous trees. However, the only such record of which I have knowledge is one taken 14 April 1942 at Taxco, Guerrero, where there are no pines, by M. L. Miles (La. State Univ. specimen).

VARIATION

Individual variability in color is moderate, but certain color factors also vary geographically, as for instance hue of the ventral yellow in *decora* and dorsal black streaking in *yaegeri*. Individual variability in wing and tail length is rather great. (See Tables 1 and 2.)

Sexual dimorphism in size is slight but definite; males average larger. As to color, males are more bluish-gray, less brownish than females, with more tendency to black streaking on the back. But this sexual dimorphism in color varies geographically, being consistent and stronger in *graciae* and *decora*, less consistent and slighter in *yaegeri* and *remota*. Sexual dimorphism of fall immatures, *inter se*, is relatively about the same as that of adults. I fail to detect any sexual dimorphism in the juvenal plumage.

In general, fall immatures as compared with adults are slightly browner, with less tendency to dorsal streaking, in the same sex in any one geographic area. In *graciae*, immatures also average smaller and paler yellow below.

I compared 18 skins in the streaked brown juvenal plumage: two of *graciae*, seven of *yaegeri*, eight of *remota*, and one of *decora*. Differences due to foxing were greater than those due to geography, but it was clear that *graciae* was more rufescent, less grayish than the more southern races, and that *decora* was less streaked ventrally than the others.

Study of molts was difficult because: (1) There were only three clear-cut specimens of *graciae* taken between late September and mid-April. (2) There was a scarcity of aged specimens of all populations. The juvenal plumage is replaced by a partial postjuvenal molt (complete except for the flight feathers) in June or July to July or August. This is a rapid molt, much of it accomplished while the young are still being fed by their parents. Specimens were examined that had completed this molt as early as 14 July (Arizona), 5 July (Guerrero), and 9 August (Honduras).

There may very well be a partial prenuptial molt in the race *graciae*, but I have not seen such molting specimens. Indirect evidence suggesting the existence of such a molt is the fact that in this race the plumage of the immatures (especially the males) differs distinctly from that of adults in winter plumage, whereas the differences the following May are slight indeed. I have seen no specimens of *graciae* taken between 21 February and 12 April. In the southern races there is even less evidence for the existence of a prenuptial molt. The postnuptial molt extends from late June, July, or August to August or early September. The earliest taken specimens with aged skulls that had completed the molt were taken 8 August (Michoacan), 9 August (Guerrero), and 3 September (Arizona).

GEOGRAPHIC VARIATION

Eleven characters in adults and three in immatures were studied. Only fresh-plumaged birds (arbitrarily defined as summer birds over halfway through the postnuptial molt and on through specimens taken 28 January) were used below for color comparisons. Capitalized color names refer to direct comparison with the color standard of Palmer and Reilly (1956).

1. Width of the white area on the inner web of the 3rd rectrix (counting from the outside) was used by Griscom (1935) as a subspecific character. It varies geographically, but not to the extent postulated by Griscom. I was able, consistently, to distinguish only two categories—"wide white" and "narrow white."

Tail white in fresh-plumaged adults

Race	*Sample size*	*% narrow white*
graciae	25	60
yaegeri	14	22
remota (including Michoacan and Honduras)	19	26
decora	4	100

2. Griscom *(op. cit.)* used the color of the posterior part of the superciliary stripe (white or yellow) as a subspecific character. I found that there was a slight, average tendency for the posterior part of the superciliary stripe to be white in the north and yellow in the south. I counted the fresh-plumaged adult specimens in which there was no white in the posterior part of the superciliary stripe as follows:

Race	*Sample size*	*% with no white*
graciae	25	0
yaegeri	16	12
remota (incl. Michoacan but excl. Honduras)	21	10
remota (Honduras only)	8	50
decora	4	0

3. According to Ridgway (1902), Griscom *(op. cit.),* and Brodkorb *(op. cit.)* the posterior extent of the ventral yellow varies geographically. It is true that in adult males the yellow of the breast extends farther posteriorly (onto the belly) in most Central American specimens than in most U.S. specimens. The variation due to make of skin exceeds that due to geography, however, and I cannot evaluate this character.

4. Brodkorb *(op. cit.)* noted the geographical variation in bill shape, with the comment that it was not adequately represented by measurements. My observations agree with his, and can be tabulated thus:

Heaviness of bill in lateral view, adults

Slender, subulate	*More robust and longer*	*More robust and shorter*
all *graciae*	about ½ of *yaegeri*	all of *decora*
about ½ of *yaegeri*	all of *remota* (incl. Michoacan, but excl. Honduras)	all Honduras specimens of *remota*

Several intermediates, especially of *yaegeri* and Honduran *remota,* are difficult to allocate to the above categories.

5. The pale (not streaked) areas of the posterior underparts are suffused with buff in some northern specimens. For the purposes of this table, the intermediate populations of Michoacan and Honduras are lumped with *remota.* Four categories were separable:

Posterior underparts of fresh-plumaged adults

Strongly suffused with pale Buffy Brown	*Suffused with very pale Buffy Brown*	*Weakly suffused with very pale Buffy Brown*	*White or nearly so*
4 *graciae* ♀	7 *graciae* ♀		13 *remota* ♀
	4 *yaegeri* ♀		1 *decora* ♀
	14 *graciae* ♂	2 *yaegeri* ♂	8 *yaegeri* ♂
	2 *yaegeri* ♂		16 *remota* ♂
			3 *decora* ♂

6. The dorsum is often streaked more or less heavily with black, with variation both sexual and geographical. Rather obviously segregation of races on this character is erratic. Honduras is included with *remota* in the table.

Streakiness of back in fresh-plumaged adults

Much, broad streaking	*Moderate, broad streaking*	*Moderate, narrow streaking*	*Streaking absent or nearly so*
	1 Michoacan *remota* ♀	2 *graciae* ♀	9 *graciae* ♀
		2 *yaegeri* ♀	2 *yaegeri* ♀
	2 *remota* ♀	4 *remota* ♀	6 *remota* ♀
1 Jalisco *yaegeri* ♂	10 *graciae* ♂	2 *graciae* ♂	1 *decora* ♀
	2 *yaegeri* ♂	5 *yaegeri* ♂	2 *graciae* ♂
2 Michoacan *remota* ♂	1 Michoacan *remota* ♂	3 *remota* ♂	4 *yaegeri* ♂
3 *remota* ♂	7 *remota* ♂	3 *decora* ♂	

7. The hue of yellow on the throat and breast. In general, there is a smooth cline in each sex from yellower in the U.S. to oranger in British Honduras. Honduras and Michoacan are included with *remota* in the table. However, I made a division into six categories (3 for females and 4 for males):

Hue and intensity of yellow on anterior underparts of fresh-plumaged adults

Pale and yellow	*Brighter and orangish yellow*	*More orangish yellow*	*Still brighter and yellowish orange yellow**	*Deep orange yellow*
11 *graciae* ♀	4 *yaegeri* ♀	12 *remota* ♀ 1 *decora* ♀		
	11 *graciae* ♂	3 *graciae* ♂ 7 *yaegeri* ♂	2 *yaegeri* ♂	3 *decora* ♂
	3 *yaegeri* ♂	5 *remota* ♂	11 *remota* ♂	

8. Color of the back is the most variable character, geographically. In fresh-plumaged adult males, a tabular representation is:

Browner ← → More bluish gray

14 *graciae*	12 *yaegeri*	3 Michoacan *remota*	9 "typical" *remota*	3 *decora*
Browner and less bluish gray than all others	Paler, warmer, less bluish than *remota*; warmer and less bluish than *decora*	intermediate between *yaegeri* and "typical" *remota*	Darker, warmer, less purely blue gray than *decora*	More purely blue gray than all others

4 Honduras *remota*

More drab than *decora*; less bluish and paler than *remota*

There is no overlap among the samples of the four races if the Michoacan and Honduras populations are omitted. Of these, both are best regarded as "intermediate, nearest *remota*"; the Michoacan sample is slightly browner than more "typical" *remota*, thus tending toward *yaegeri*; the Honduras variant of *remota* is more drab, less purely bluish gray than *decora*, and less bluish and paler than "typical" *remota* from Chiapas, Oaxaca, and Guerrero.

In fresh-plumaged adult females geographic variation in back color is even greater than in males, but the pattern is not wholly parallel.

* Categories of columns 3 and 4 were not differentiated in females.

A tabulation is:

Browner ←			→ Bluer
		4 Honduras *remota*	1 Michoacan *remota*
11 *graciae*	4 *yaegeri*	*1 *decora*	8 "typical" *remota*
Brown; all others more or less gray	Browner, more olivaceous, less bluish than *remota* and *decora*	Slightly browner, less bluish gray than "typical" or Michoacan *remota*	More bluish gray than all others

9. Length of wing in adults shows a definite cline from shorter to the south to longer in the north. Measurement was of the chord. Overlap between adjacent races is considerable. Length of wing in females varies in a pattern closely parallel to that in males (see Table 1).

10. Length of tail in adults shows a cline very similar to that of the wing length (see Table 2). Wing-tail difference, calculated by subtracting the mean for adult males for tail length from that for wing length, is perhaps more expressive than either simple value. The wing-tail difference to the nearest half millimeter is: U.S. *graciae* 18; Chih., Son. *graciae* 17; *yaegeri* 17.5; Michoacan *remota* 16; Guer., Oax.

TABLE 1

LENGTH OF WING IN ADULT MALES

Race	*Locality*	*Sample size*	*Range*	*Mean*	*Standard deviation*	*Coefficient of variation*
graciae	United States	90	62-70	66.54	1.75	2.64
graciae	Chih. and Sonora	33	60-69	64.85	1.61	2.49
yaegeri	Dur., Zac., Nay., Jal.	29	62-69	64.83	1.64	2.53
remota > *yaegeri*	Michoacan	5	62-65	64.00	——	——
remota	Guer. and Oax.	12	57-65	61.50	1.98	3.22
remota	Chiapas	19	59-66	61.89	1.95	3.15
remota	Guat., Honduras, Nicar., Salvador	34	56-63	59.53	1.56	2.62
decora	Brit. Honduras	17	54-61	57.00	1.81	3.18

* This single specimen of *decora* in fresh female plumage is probably an extreme. In a similar comparison of worn female material, including 15 *decora*, four matched the Oaxaca-Chiapas-Salvador-Honduras-Nicaragua series of 26 *remota*, but 11 were bluer and less brown than any *remota*, thus paralleling the results on both fresh and worn males and invalidating the above comparison of a single fresh female. [Worn specimens, of which many more were compared than of the fresh-plumaged birds tabulated above, could usually be sorted into the same categories on the basis of dorsal color and of hue of the ventral yellow.]

TABLE 2

LENGTH OF TAIL IN ADULT MALES

Race	*Locality*	*Sample size*	*Range*	*Mean*	*Standard deviation*	*Coefficient of variation*
graciae	United States	90	47-53	48.68	1.37	2.82
graciae	Chih. and Sonora	33	44-51	47.82	1.56	3.27
yaegeri	Dur., Zac., Nay., Jal.	28	45-50	47.29	1.19	2.52
remota > *yaegeri*	Michoacan	5	46-48	47.60	—	—
remota	Guer. and Oax.	11	44-47	45.46	1.08	2.36
remota	Chiapas	19	44-49	46.68	1.41	3.03
remota	Guat., Honduras, Nicar., Salvador	33	43-48	44.61	1.15	2.84
decora	Brit. Honduras	17	41-48	44.29	1.56	3.53

remota 16; Chiapas *remota* 15; Guat., Hond., Nicar., Salv. *remota* 15; *decora* 13.

11. Weights were available on the labels of 84 specimens. However, they were so scattered through the months of the year and the geographic range of the species that no definite pattern could be seen. Range for males was 6.9 to 10.5 g and for females 6.7 to 9.6 g.

Immatures in fresh plumage (July to December) were compared as to color of the back, color of the yellow of anterior underparts, and color of the pale areas of the posterior underparts. There were 27 females of the races *graciae, yaegeri,* and *remota* and 36 males of the same three races available; the sexes were compared separately. Differences paralleled those noted above for adults, but were somewhat more clear cut as regards hue of the ventral yellow. Specifically, separation of each of the races was 100 per cent, from 100 per cent for color of the back in both sexes and color of the posterior underparts in males. Separation of the races with slight overlap of extremes was observed for hue of the ventral yellow in both sexes. Color of the posterior underparts in females made a complete separation between *graciae* and *remota,* but *yaegeri* overlapped both other races considerably.

DISCUSSION OF TAXONOMY

The race *ornata* was clearly described by Brodkorb (1940) from Chiapas. Unfortunately, Brodkorb did not compare his new race with *remota,* which had been very briefly described by Griscom in 1935, from northwestern Nicaragua, on the basis of eight worn April and May specimens. I borrowed four of the paratypes from the British Museum (through the courtesy of R. W. Sims) and compared them

with the type and many other specimens of *"ornata"* at the University of Michigan Museum of Zoology. Although topotypes in fresh plumage of *remota* were not available, the subspecific identity of the two populations (Chiapas and Nicaragua) was very clear. A slight tendency to brownness in the posterior underparts of three of the four paratypes of *remota* was the only departure noted from the coloration of Salvador, Guatemala, Chiapas, and Honduras birds. I recognize *remota,* then, not as an isolated race from northwestern Nicaragua, but as a widespread subspecies occupying the Pacific coast of southern Mexico plus most of Central America.

I recognize all of the other races of *Dendroica graciae* that have been described. The reluctance of Miller *et al.* (1957: 253) to recognize *ornata* as distinct from *decora* is no doubt due to misunderstanding of the respective ranges involved.

RESUME OF THE SUBSPECIES

Dendroica graciae graciae Baird

Dendroica graciae Baird 1865, *Rev. American Birds,* sign. 14, p. 210 (Fort Whipple, Arizona)

Diagnosis. Back and posterior underparts browner than in all other races. Yellow of throat and breast paler and less orange than in all other races. Dorsal black streaks broader and commoner than in *yaegeri* and *decora,* but fewer and narrower than in *remota.* Bill more slender and subulate than in all other races. Wing and tail longer than in all other races.

Range. Breeds in pines from southern Utah, southeastern Colorado, and western Texas south through the Sierra Madre Occidental of Chihuahua and eastern Sonora to southern Chihuahua (Sierra del Nido). Three clear-cut winter specimens were examined: Amecameca, state of Mexico, 28 January 1943 (La. State Univ.); five km north of Tres Marias, Morelos, 20 December 1948 (Texas A. & M. Univ.); 10 km west of Tepic, Nayarit, 21 February 1955 (Phillips collection). A male from Taxco, Guerrero, 14 April 1942 (La. State Univ.) is a migrant or vagrant but not certainly distinguishable between *graciae* and *yaegeri.*

Dendroica graciae yaegeri Phillips and Webster

Dendroica graciae yaegeri Phillips and Webster 1961, *Auk,* 78:551 (Cerro San Juan, west of Tepic, Nayarit)

Diagnosis. Back bluer, less brown, than in *graciae,* but browner and less bluish (adult males also paler) than in *remota.* Posterior underparts

less buffy than in *graciae*, but more buffy than in *remota*. Throat and breast brighter and more orange than in *graciae*, but duller and more yellowish than in *remota*. Dorsal black streaks fewer and narrower than in either *graciae* or *remota*.

Range. Breeds in pines of eastern flank of Sierra Madre Occidental in southern Durango and western Zacatecas; also more coastal ranges in southern Sinaloa, Nayarit and western Jalisco. Winter specimens were examined from near Tepic, Nayarit; near Autlan, Jalisco; and (migrant or vagrant) near Patamban, Michoacan, 28 January 1903 (U.S. Nat. Mus.). As noted above, a specimen from Guerrero is a migrant or vagrant of either *graciae* or *yaegeri*.

Dendroica graciae remota Griscom

Dendroica graciae remota Griscom 1935, *Ibis*, p. 548 (Volcan Viejo, Chinandega, Nicaragua)

Diagnosis. Back darker than either *yaegeri* or *decora*, browner and less purely blue gray than *decora*, but more bluish than *yaegeri*. Posterior underparts indistinguishable from those of *decora*, but whiter and less suffused with buffy than those of *yaegeri*. Throat and breast brighter and a more orangish hue of Yellow than in *yaegeri*, but paler and a more yellowish Orange Yellow than in *decora*. More and broader dorsal black streaks than in any other race.

Range. Resident in pines of mountains of Michoacan (Patzcuaro, 19 km east of Morelia, 19 km west of Hidalgo) and southwest in the Pacific coastal slope pines of Guerrero, Oaxaca, Chiapas, Guatemala, and Salvador; also across Central America in middle-elevation and low-elevation pines in Chiapas (Laguna Ocotal), Guatemala (Sierra de las Minas), Honduras (Cerro Cantoral, San Esteban, etc.), and Nicaragua (Volcan Viejo).

There is more variation within *remota* than within any of the other races here recognized. To the north, the Michoacan population shows considerable tendency toward *yaegeri*, especially in size and hue of the ventral yellow and also is more heavily streaked with black dorsally than any other population of the species. To the south, the Honduras population (and probably that of northwestern Nicaragua, if fresh-plumaged specimens were available) shows a tendency toward *decora* in shortness of the bill and slightly less dorsal streakiness; the same population shows an independent trend in another direction, being slightly more brown or drab than more northern populations of *remota*.

A single February specimen from the northeastern coast of Nicaragua (UCLA) from pines at an elevation of 33 meters has the color of

decora but the size of *remota*. More specimens in fresher plumage from this area will be necessary in order to settle the racial identity of the population.

Dendroica graciae decora Ridgway

Dendroica graciae, var. *decora* Ridgway 1873, *Amer. Nat.*, 7, p. 608 (Belize, British Honduras)

Diagnosis. Back more purely gray than in any other race. Posterior underparts indistinguishable from those of *remota*. Throat and breast a deeper, more orangish orange-yellow than in any other race. Streakiness of the back less than in *remota* and *graciae*, but about the same as in *yaegeri*. Bill relatively short but robust. Wing and tail averaging shorter than in any other population.

Range. Resident on the "pine ridges," near sea level, along the coast of British Honduras.

BREEDING OR RESIDENT SPECIMENS EXAMINED

(Wintering and migrant specimens are listed above.)

D. g. graciae—Arizona 110; New Mexico 11; Texas 4; Sonora 3; Chihuahua 49.

D. g. yaegeri—Durango 4; Zacatecas 4; Nayarit 20; Jalisco 13; Sinaloa 1. (Includes all the cotypes of *D. g. yaegeri* Phillips and Webster.)

D. g. remota—Michoacan 12; Guerrero 18; Oxaca 7; Chiapas 37 (including type of *D. g. ornata* Brodkorb); Guatemala 1; El Salvador 9; Honduras 38; Nicaragua 5 (including 4 paratypes of *D. g. remota* Griscom).

D. g. decora—British Honduras 34.

SUMMARY

Grace's Warbler has a more or less clinal pattern of variation along a long, narrow, northwest-southeast range, from Utah to Nicaragua in pine forests. Four races are recognized, each with a fairly extensive range. Migration is long in the northern race, short and variable in the next race, and lacking in the two southern races.

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THE EARED POOR-WILL

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The Eared Poor-will, *Otophanes mcleodii* Brewster, has remained one of the least-known birds of the North American continent since it was first described by Brewster (1888) from a specimen collected by McLeod in Chihuahua. A second specimen was collected near San Marcos, Jalisco, by Lloyd, in 1889 and was recorded by Salvin and Godman (1894: 391). Thereafter, nothing new concerning the species was published for half a century. A previously unreported specimen (a female) in the American Museum of Natural History was taken by J. H. Batty on 31 May 1905 at La Laja, Jalisco, supposedly at *ca.* 3,000 meters, although, as noted below, this is most probably an inaccurate estimate. Finally, two more specimens were secured in Guerrero, in 1938 and 1941, by the veteran collector W. W. Brown, Jr. The first series (four specimens) was taken a few years later by W. J. Sheffler and E. N. Harrison on the Sonora-Chihuahua border. All of these recent specimens were recorded by Miller (1948), who named the Guerrero birds as a race distinct from the Sonora-Chihuahua series on the basis of color differences between one male and one female of each. This closed the history of our knowledge of the species until 17 February 1959.

At about 2200, on that night, as we drove toward Autlán de Navarro, southwestern Jalisco, from the coast at La Barra de Navidad, we saw two small night-jars alight briefly in the drainage ditch by the roadside ahead of us. Realizing the possible significance of the birds, we began to hunt the nearby precipitous slopes of the mountain. Eventually, by means of a beam from a head lamp, the senior author located three birds in an oak; two of these were calling steadily. One of the calling birds was collected (S 5893)[1] and proved to be the elusive *Otophanes mcleodii.*

Further strenuous efforts yielded no other specimens that night. We therefore pitched camp at the nearest possible site, at La Cumbre, a pass in the foothills of the Sierre de Autlán, 15.7 kilometers (9.4 miles) south-southwest of Autlán de Navarro. (All distances given are by automobile speedometer.) At this spot six kilometers (3.6 miles) north-northeast from the original point of observation, these poor-wills were also calling. The night was clear, with the moon about one third full. The following evening, again clear and moonlit, our assistants collected two specimens (WFVZ 5435) near this camp, while the junior author obtained another at the original site.

[1] S = Sheffler Collection; WFVZ = Western Foundation for Vertebrate Zoology.

Subsequently, we found *Otophanes* to have a fairly wide distribution in southwestern Jalisco and adjacent Colima; the senior author, in April and May 1959, secured a series from La Cumbre and from other points. The first known young and eggs were also discovered. Thus, our combined field notes enable us to present a brief account of this virtually unknown species.

ECOLOGY

The Eared Poor-will seems to be, essentially, a species of dry, semi-open oak or pine-oak slopes and barrancas at middle altitudes. We have never found it on the low, arid plains of Colima or coastal Jalisco, in the Arid Thorn Scrub and Arid Thorn Forest. However, a rectrix was found and a bird heard calling on 26 May 1959 where these plains are dissected by the cliff-bound Río Naranjo, 36.7 kilometers (22 miles) east of Colima City. The river is narrowly bordered at this point by tall Gallery Forest, but it is probable that the features of this locality attractive to *Otophanes* are the steep, rocky slopes and the cold air drainage down the canyon from the east slope of the Volcán de Colima. Likewise, we have never found the species in the dense Humid Pine-Oak Forest nor in Fir Forest of the higher altitudes. (Capitalized vegetation zone names used herein follow the terminology adopted by the senior author in a forthcoming paper on the avifauna of Colima and adjacent Jalisco.) During a period of eight weeks spent in various field camps in the upper Sierra de Autlán and on the upper slopes of the Volcán de Colima, no *Otophanes* were observed. Conversely, with the sole exception of the Río Naranjo area, we found it at no point below the lowest oaks.

Salvin and Godman *(op. cit.)* state that their specimen was collected by Lloyd ". . . on 11th May, 1889, at an altitude of 8,000 feet above the sea level in the mountains of Jalisco." This altitude on the Volcán de Colima would be well into the Humid Pine-Oak Forest; Batty's supposed altitude would, of course, be still higher. While on a trip to Great Britain this summer, however, the senior author had the opportunity to examine Lloyd's specimen in the British Museum. Lloyd's original field label on the specimen states clearly that the elevation was 5,000 feet (1,600 meters); this is almost exactly the same altitude where the senior author observed and collected *Otophanes,* in May 1959, near San Marcos, Jalisco (WFVZ 6091). The general altitudinal range of the species in the Colima-southwestern Jalisco region can thus be considered as between 660 and 2,000 meters above sea level. In addition to the areas previously mentioned, we observed and collected

Otophanes at Hacienda San Antonio, on the south (Colima) side of the Volcán de Colima, and in and near the Barranca Beltrán, a few kilometers west and northwest of San Marcos.

LIFE HISTORY

Otophanes mcleodii is a typical poor-will in habits, although possibly a bit more active through the night than other caprimulgids. During the active breeding season, we have heard it calling shortly after dusk, at and after midnight, and again just before dawn. On one dark, foggy night in early May, at La Cumbre, the birds called steadily until midnight, and a male, still calling vociferously, was collected at 0215. The period of maximum calling activity, in May, is from dark to about 2200 after which the calls become more sporadic. We have never heard one call nor seen one fly in daylight.

Both sexes call with a striking, clear whistle, which has a falling cadence. The long note is often preceded by a shorter, more abrupt note on the same key. The call sometimes has a slight quality of a double whistle, as though it had an overtone; the whole call may be represented by the letters: *kee-keeoor*. Besides this characteristic call, our assistants state that the female occasionally utters a short, trilled, "churring" note when disturbed. The birds respond readily to a whistled imitation of the call, but do not normally move from their calling position. However, on 8 April 1959 a male (WFVZ 5639), which had been steadily answering the senior author's whistles, came a distance of nearly a kilometer across a deep barranca, by short flights, and finally alighted on a low oak sapling not five meters away from his calling position. This was, perhaps, at the height of the breeding season.

We do not know whether the birds call after the breeding season, since from 19 May to 23 June 1959 we were in other areas; in July, however, several hours were spent in listening for calling birds on the lower slopes of the Volcán de Colima. None was heard, nor were any calls noted during similar surveys in November and on 29 December at La Cumbre. There is no good evidence that *Otophanes* migrates, although a certain amount of local wandering is suspected; its year-long distribution remains poorly understood.

The first two males collected (S 5893, WFVZ 5435), on 17 and 18 February, had slightly enlarged testes: the first had testis measurements of 5 x 2 and 4 x 2 mm.; the second, 3 x 2 and 3 x 2 mm. Both were calling vociferously when collected. The male collected on 8 April (WFVZ 5435) had larger testes, 7 x 4 and 5 x 3 mm. A male

(S 6155) collected on 29 April had testes of exactly the same size and was also calling steadily. A female (S 6139) collected the same night held two large ova, 14 x 12 and 12 x 11 mm. She was in the company of three other birds, all calling continuously from the ground near a rock outcrop. Two of the accompanying birds were also collected and proved to be males (S 6140, S 6158) with enlarged testes. One of these males, when picked up from the ground after the shot, was found to have been incubating two eggs. Unfortunately, both eggs were destroyed by the dust shot. The nest was a round, bare, scraped-out depression on the ground, in short grass, at the base of the cliff. All of the specimens mentioned above were taken in the La Cumbre area.

Another male (WFVZ 6091) was shot on a nest on 6 May, in a thick covert of pine *(Pinus teocote)*, 4.2 kilometers (2.5 miles) west of San Marcos, Jalisco. This bird also had greatly enlarged testes and had called sporadically. This time the two unspotted, ivory-white eggs were saved intact; they form the first clutch known of this species. The nest was a bare patch of dirt scraped out of the pine needles. On 9 May, in the La Cumbre area, a female (S 6228) was collected on the nest. Both eggs were slightly damaged by the dust shot, but were successfully patched up and form the second known clutch. This bird had the ovary enlarged and the oviduct well developed, but had no large, developing ova. On 16 May, in the San Marcos area, a male (WFVZ 6294) and a female (WFVZ 6295) were taken. The male had enlarged testes, but the female had the ovary only slightly enlarged. Both were calling from the limbs of pine trees. Our last specimens were taken on 18 May, at a point an estimated five kilometers (three miles) by trail northeast of Hacienda San Antonio, Colima, in a dry pine and grass area. These specimens represent the first record of occurrence of the species within the state of Colima. The male (S 6310) was calling from the ground at the edge of a steep barranca; it had enlarged testes. The female (WFVZ 6317), however, was silent. She was covering a single fledgling on a nest of bare earth; the ovary was only slightly enlarged. The chick was collected and preserved in alcohol for a possible later anatomical study and description.

From the foregoing data on reproductive status, we deduce that the breeding season in this region begins sometime in February. Egg laying probably begins about 20 April, and the nesting period then lasts at least until late May.

From our scanty observations on *Otophanes* in other than reproductive activities, we feel safe in saying that the species will be found to be typically caprimulgid in most of its habits. When feeding, the

Eared Poor-will does so from a clear spot near brush or tall grass, from which it flutters up about one meter above the ground to catch insects; this behavior is very similar to the feeding jumps of *Phalaenoptilus nuttallii*, although *Otophanes* may not fly quite as high as does the latter. When perched on tree limbs, it does so in the typical manner of the family, *i.e.*, lengthwise along the limb: we have no evidence that it feeds from a tree perch. If one brief observation is typical, the mouth gapes open widely when calling. Most of the calling was done by birds on the ground or on rocks, but, as noted previously, some birds definitely called from tree perches. The stomach contents of several birds were noted as "unidentified insect remains."

The following soft parts description is appended, since, to the best of our knowledge, no complete description of these parts has been heretofore published. This description was taken from an adult male (S 6155), shot about 2300, 29 April 1959 at La Cumbre, Jalisco. The bird was examined at 0700 the next day, in full daylight, and the following notes made:

Culmen dusky, tip almost black. Mandible light gray. Bare skin at chin pinkish-flesh. Mouth white, inside of mandible pinkish. Iris dark pinkish-brown. Front of tarsometatarsus violaceous-gray, pinker behind. Feet and claws dusky. Sole of foot buffy to grayish-buff. The "ears" are not obvious in the field.

Other night birds taken in the same areas with *Otophanes* were *Otus trichopsis, Glaucidium gnoma, G. minutissimum, Caprimulgus vociferus, C. ridgwayi,* and *Nyctidromus albicollis.*

VARIATION

As long ago as 1894, on the basis of the two then-known specimens, Salvin and Godman, with remarkable acuity, pointed out that the female is redder throughout than the male. The considerable series now available bears out this sexual dimorphism; it is seemingly most constant on the scapulars, on the rump, and, to some extent, on the rectrices. There also seems to be, however, a definite seasonal variation in color due, in all probability, to wear and to the stages of the molt. Our May specimens do not differ appreciably from the May series taken by Sheffler and Harrison on the Sonora-Chihuahua border. Our February birds, however, average considerably darker. None of our specimens, taken in February, April, and May, was molting. It would thus appear that *Otophanes*, like various other caprimulgids, has a single annual molt, in late summer.

The specimens mentioned above are, with one exception, deposited in the permanent collection of the Western Foundation of Vertebrate

Zoology, Los Angeles, California, and in the private collection of Mr. W. J. Sheffler, of Los Angeles.

ACKNOWLEDGMENTS

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NESTING ACTIVITIES OF THE RED-FOOTED BOOBY IN BRITISH HONDURAS

JARED VERNER

FROM 14 February to 9 May 1958 I conducted an intensive investigation of the breeding activities of the Red-footed Booby (*Sula sula sula* Linnaeus) on Half Moon Cay, 80 km east of Belize, British Honduras. The detailed results of the study appear in my thesis for the degree of Master of Science (Verner, thesis submitted 1959).

Half Moon Cay (Figure 1) is a tiny coral island, 1.16 km in length, supporting mainly coconut palms *(Cocos nucifera)*. The floor of the narrow eastern half of the cay has been cleared, and the palms there are planted in rows. On the western portion, exclusive of the booby colony, the palms are distributed naturally, the floor beneath being covered with lush, mat-forming herbs. Within the booby colony very few palms are present; instead, eight species of broadleaf trees form a nearly continuous overhead canopy from about six to 15 meters above the ground. The number of booby nests in each species of tree fairly well indicated the relative abundance of each species (Table 1). The floor of the colony is composed of coral stones, which permit potential humus to percolate away with the rains. As a result, there is little in the way of an herbaceous understory.

The only undomesticated mammal on the cay is *Rattus rattus*. Ninety-eight species of birds were recorded during the course of the study. At least 77 of these were migratory forms, and, of these, only 17 were recorded regularly enough to indicate that they winter on or near the island. Two species, the Red-footed Booby and the Magnificent Frigate-bird *(Fregata magnificens)*, were nesting at the time of the study; and probably both the White-crowned Pigeon *(Columba leucocephala)* and the Groove-billed Ani *(Crotophaga sulcirostris)* nested there later in the year. A number of small lizards and two larger ones, the False Iguana *(Ctenosaura similis)* and the Iguana *(Iguana iguana)*, were abundant. Nothing was observed to substantiate the many reports that these larger lizards harm nests, eggs, and young of the Red-footed Booby.

The climate at Half Moon Cay is generally mild, although the high humidity makes even slight temperature differences more noticeable. Temperatures were recorded three times daily—morning, noon, and night—between 20 March and 7 May and the range was from 23°C (73°F) to 32°C (90°F). With the exception of the early morning average of 26°C (79°F) in March, all three daily averages for March,

April, and May were above 27°C. During the three-month study period, which was in the dry season, it rained hard on one day and showered on four. Average annual precipitation at Belize since 1919 is 1,861 mm (73.26 inches), with a range of 1,068 to 2,779 mm (42.03 to 113.33 inches). March, with an average rainfall of 38.9 mm (1.53 inches), is the driest month; October, with an average of 309 mm (12.15 inches), is the wettest. There is nearly always a moderate easterly breeze across Half Moon Cay. This not only mitigates the effects of the high humidity but also keeps the entire island practically free of small flying insects.

Most of the observations on nesting behavior were conducted from a three-meter-high platform in a *Ficus* sp., from which over 100 occupied booby nests could be seen. The birds' indifference to all my activities made it unnecessary to place a blind on the platform. All the nests in the colony were systematically counted between 16 February and 3 March. Considering the number of nests (1,389) and the large number of non-nesting individuals present, I estimated that there were approximately 3,500 Red-footed Boobies (not counting nestlings) on the island at the time. Of that number probably 500 were immature birds that roosted in groups in various sections of the colony.

FORMATION AND MAINTENANCE OF PAIR BOND

Although pair formation was incompletely observed, two incidents provide a clue to the method employed. When a pair had its nest

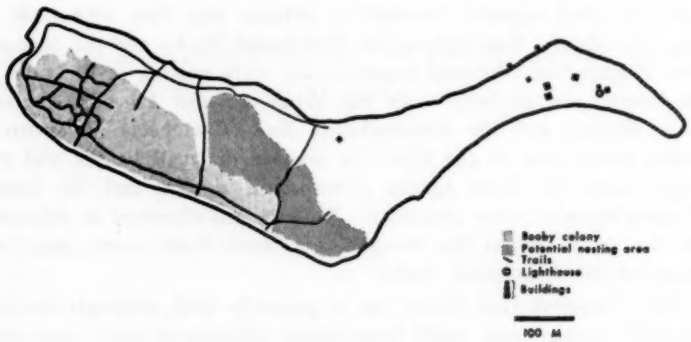

Figure 1. Half Moon Cay. The booby colony occupies 4.38 hectares (10.96 acres); the western section, where trails are concentrated, was the principal study area. The large white dot marks the location of the observation platform.

destroyed, the birds continued to maintain a territory (either the same or a new one), even if they did not attempt to renest. Several of these "nestless pairs" were observed throughout the study period, and it was from two of these that I obtained data on pair formation.

The female of nestless Pair 75 died, and the male was observed closely on the following days. Two days after the loss of his mate, the male was performing what I called the "four-point" display (Figure 2) at passing birds. The following day he was four-pointing actively to another bird that was perched on his territory about 60 cm in front of him and that occasionally responded to his four-points with a bow in his direction. Apparently the pair bond had just recently been formed between these two birds, or it was being effected at that time, since they remained paired thereafter.

In the second case Male 64 was apparently on the verge of changing mates. The pair had been without a nest for 35 days when the male, while standing beside his own mate, was seen four-pointing to a third bird (presumably a female) on a perch about five meters from his own. The second female bowed in response. During the next hour the male shifted back and forth between the two females. Both females, as well as the male, engaged in four-pointing; and the male brought twigs to both females. No other bird was observed with the second female, and the male was roosting with her at dark. The following morning, however, he was back on his own territory with his own mate, and nothing further developed. The second female was not seen again.

The "four-point" and its variations were the most frequently observed displays. In a full four-point the bill, tail, and both wing tips were directed skyward as illustrated in Figure 2C. The posture was accompanied by a single, rattling, drawn-out note (*walk*, or better, *waaalk*), usually on a low pitch and with only a slight inflection at the end, or by no call at all. The posture began with the booby extending its head and bill upward until the bill was nearly vertical, thus exposing the throat area (Figure 2A). Before this action was completed, the tail began to rise toward a vertical position (Figure 2B), and the wing tips began to rise before the head and tail were fully erected. The wings were not extended from the body, however. Instead the carpal joints were depressed and the remiges spread so the primaries were pointed nearly vertically. All the actions were slow and deliberate, and the full posture just described was not always attained. Rarely a four-pointing bird that was standing on a perch terminated the display by bowing very low (Figure 2D). Every gradation between the full pose and simply raising the head and bill slightly was observed.

The following case typifies the complete four-point display as performed only by nestless pairs but never completely by nesting pairs. The male stood on a perch facing his mate, who stood on another perch about 60 cm away. The female seemingly paid little attention to the male; but he never moved his gaze from her. He tried to command

her attention by extending his neck fully in order to thrust his bill in her direction. If she turned toward him, he began a four-point. But if she turned away before he reached the full pose, he relaxed and again thrust for her attention. Only when the female gave the male her full attention did he complete the four-point. No bird was ever seen to expand, or in any way enlarge, its gular sac during any such display.

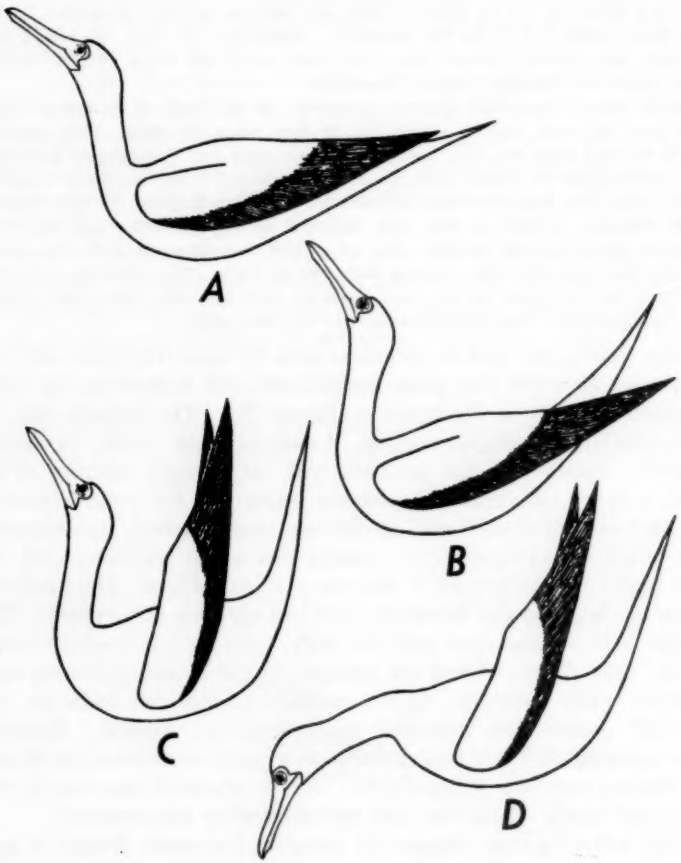

Figure 2. Stages of the "four-point" display. A, B, and C illustrate typical stages of the display with C being the usual climax position. D illustrates the "bow," which infrequently followed stage C.

The female frequently acknowledged the male's display with a bow or bill thrust in his direction, and occasionally she assumed a four-point herself, rarely attaining the full posture. During one such ritual, however, a female was initiating every four-point, and the male was responding with the same, so that both reached the full pose at nearly the same instant.

Although this display was used, especially in its incomplete stages, as a warning to trespassers, its chief importance was in courtship and maintenance of the pair bond. Since nesting males four-pointed only occasionally, it was probable that their domestic responsibilities were sufficient to maintain their pair bond. The "stick-shake" display was observed more among the nesting pairs, and perhaps served the same function as did four-pointing during the nestless period.

When a stick was brought to the territory by one partner, a "stick-wave" display followed. In performing the stick-wave, the bird stood on a perch (or the edge of the nest) with a stick in its bill, waving its head about while holding the stick and uttering a series of guttural squawks indistinguishable, or practically so, from the call given by all Red-footed Boobies when landing. The stick-wave was usually followed by the stick-shake display by both members of the pair. The stick was passed from one bird to the other, but frequently both birds held the stick and shook it mildly. Then they arched their necks forward and down together to place the stick at their feet. Without exception, when either sex or both together held the stick down at foot level to place it on their nest or perch, it was trembled or quivered into place. The stick often became quite a toy for the birds as they passed it back and forth between them. Only the males of nesting pairs gathered sticks, while both sexes of the nestless pairs did so; but the antics of the birds were the same after the stick was secured. It was finally dropped to the ground by the nestless birds, however, since they had no nest to which to add the stick.

Unlike nesting pairs, both birds of the nestless pairs were absent from the territory most of the day, invariably returning separately in the evening. Their evening behavior assumed different forms, with each pair tending to emphasize one or another feature of the general pattern of activity. For example, Pair 64 stressed the four-point and the stick-shake displays; Pair 70 usually sat quietly, while the female preened the nape and back feathers of the male, and were more active at "billing" than the others (billing by the Red-footed Booby seems to be an argumentative gesture, with one bird actually snapping suddenly at another's bill); and Pair 75 concentrated on the four-point and

actual copulation. Pair 75 was the only nestless pair that I saw copulating, although Pair 74 made several unsuccessful attempts to do so. It seems unusual that Pair 75 copulated regularly for a full month, but never attempted to build a nest. An examination of Female 75's ovary revealed no enlarged follicle, and the significance of their activity was not determined. The other activities mentioned were common to all pairs.

Several things suggest that the monogamous pair bond of this species is at least sustained, if not life-long. First, at least 10 of the nestless pairs were holding territories within view of the observation platform, and most of these pairs were first noticed about two months before I left Half Moon Cay. All remained paired and on the same territories for the remainder of the study. Second, the nesting season for the colony as a whole takes most of the year, so there would be very little, if any, time between successive seasons for a period of general courtship and pairing. Third, the fact that Male 75 remated late in the nesting season shortly after the loss of his original mate indicates an absence of a general courting period. It is of interest, too, that the newly formed pair did not change territories. This same evidence also suggests that at least some pairs maintain their territory throughout the year.

TERRITORY

The territory of the Red-footed Booby is used for nesting, copulation, and occasionally for roosting by the nonincubating mate. Usually, however, the nonincubating bird roosts on a perch that is often shared with other birds and that is removed from all territories. Each territory, therefore, is small, probably not exceeding 0.6 square meters and includes only the nest and the adjoining three or four perches used for landing and take-off. In most cases neighboring territories were not contiguous; in fact by far the largest portion of the colony was not defended by any pair.

The stick-wave display was apparently used to denote territorial ownership and probably also helped to maintain the pair bond of both nestless and nesting pairs. In most cases where the sex was known, this display was performed by males; however, on a few occasions nestless, paired, territorial females were observed gathering nest materials, and they were also seen stick-waving. Therefore, it seems that stick-waving normally follows the return to the territory with nest materials and is common to both sexes. The infrequency of stick-waving by females is probably attributable to the fact that they gather nest materials only for a brief period prior to nest construction. On several

occasions, immature birds that had nearly attained adult plumage were observed giving the stick-wave. One such bird occasionally gave the display, always from the same perch, for a period of at least two months. It not only waved the stick about and squawked loudly but also made several motions as though to place the stick on its perch. The bird was present at its perch every evening, and frequently it engaged in lively battles with nesting adults whose territories were nearby. In several cases the immature seemed to be deliberately challenging the other birds to dispute his right to that spot. To me these activities were suggestive of territorial selection.

On the basis of indirect evidence, I suspect that the male selects the territory. The male of a nestless pair that was maintaining a territory was killed; the female was marked and her movements traced after the death of the male. In two days she had deserted the territory and was roosting in the evenings near the observation platform. In a second case, mentioned earlier, the female of a nestless pair died and the male soon acquired a new mate while remaining on his original territory. This was on 26 April, when most pairs already had young well advanced. The pair remained on the territory but never attempted to nest.

Territorial defense was at times quite fierce. Boobies were frequently seen biting and jabbing each other, and occasionally one gripped another around the neck so tightly the victim was unable to free itself. Such encounters sometimes lasted for several minutes. As a rule, however, threat displays sufficed for territorial defense. Adults and moderate-sized young alike were active in defending the territory against all intruders, including other boobies, frigate-birds, iguanas, and humans. Although the degree of resistance to me varied considerably among individuals, nearly every adult booby stood its ground at the nest until it was removed bodily. The first few times that I disturbed them, the birds were very active in resisting me, squawking loudly while biting and stabbing at my hand and a stick I used to force them off the nest. But gradually they became accustomed to my intrusions and tried only to bite me, paying little attention to the stick and not squawking. They reacted similarly to a mirror on a long pole that was used to examine the contents of nests high in the trees. Adults would not attack a strange downy young if one was moved from its nest to a strange nest, but nestlings fiercely resisted intrusion by other young. Smaller young on their own nest invariably subdued larger young introduced from other nests. After the young birds had begun to darken through acquisition of the juvenal plumage, they were forcefully driven off by adults when they strayed or were placed on the wrong territory.

I called the principal threat display the "one-point." Both sexes gave the display, but males were generally more aggressive. In a typical, exaggerated one-point, a booby thrust its bill forward toward the intruder and waved its head slowly and methodically from side to side. Usually, though not invariably, this action was accompanied by a series of loud squawks, normally with a screeching quality. Ordinarily, the threat was given from a sitting position by an incubating bird; however, birds also one-pointed while perched. In its mildest form, the one-point involved only the forward thrust of the bill without the head waving or calling, and all gradations between the two extremes were observed. I was frequently unable to distinguish between a weak one-point and the very early stage of a four-point.

NEST

Since only the males of nesting pairs, and both males and females of nestless pairs, were observed gathering nest materials, and since the females of the nestless pairs were invariably the first noted and the most active at gathering materials, it is likely that female Red-footed Boobies initiate nest construction. The males then assume the gathering responsibilities, while the females carry on most of the actual construction.

The only nest for which the complete construction was observed was a second attempt by Pair 22, which had their territory six meters in front of the observation platform. These birds lost their egg on 15 February but clung to their original territory after the loss. However, they both left the territory during midday, and neighboring boobies and frigate-birds took all the material from their nest. This common practice in the booby colony dictated that at least one member of a pair be on guard at all times to protect the nest even before the egg was laid. I saw nests completely stripped and added piece by piece to other nests in half an hour! On 4 March Pair 22 had definitely begun to build a new nest in the same position as their first. At 1747 they copulated at the nest site; then the male flew off while the female guarded the new nest, which consisted of a very few sticks at that time. At 1803 the male returned with a twig bearing dying leaves that was probably taken from a nest recently deserted by another pair.

The male guarded their nest all the following day. At 1622 his mate returned, and the two birds immediately began to adjust nest materials. Between 1627 and 1757 the male brought 41 separate sticks for the female to add to their nest; all but two were taken from a vacant nest 3.8 meters away. Each time the male returned to the nest with a stick he squawked loudly just before alighting. After landing he performed the stick-wave display so that the call and actions of landing were continuous with the call and actions of the stick-wave. Occasionally the female responded with a soft, squawking chatter. She invariably made the final placement of each stick on the nest, although the male often helped her move the stick toward the nest. All the sticks collected that day were added to the rim of the nest, with the female working all of them in about her and

occasionally turning around and around in the bottom of the nest. Without fail each stick was quivered or trembled into place. Just before dark the birds copulated and then settled down to roost.

For the next few days, one or the other of the birds guarded their nest, and construction continued more slowly. At 1112 on 12 March, just eight days after their nest was begun and 25 days after the loss of their first egg, Female 22 laid another egg.

The birds continued to add to their nest occasionally throughout incubation and even after the young was hatched. Other pairs were also observed adding to their nests after they had young; in fact, one male was seen collecting nest material a month after the egg had hatched. Twigs, freshly broken and bearing fresh leaves, were added to the lining of the nest before the egg was laid and *throughout incubation*, and dry leaves were occasionally removed from the lining. Fisher (1903) wrote that at Laysan Island he found leaves scattered under the eggs in newer nests. He used these leaves as a crude index to the incubation stage of an egg, assuming that the drier they were the longer the egg had been incubated. However, since fresh leaves were added to the nest lining throughout incubation at Half Moon Cay and incubation takes about 45 days, this sort of index is invalid.

Below the nests at Christmas Island, in the mid-Pacific, Streets (1877) noted mounds of twigs that were sometimes cemented together with excrement. "It probably afforded them diversion during the monotonous period of incubation to break off all the twigs within reach of their bill, and to drop them under their nests. These mounds furnish evidence of the nests being occupied for several successive years; for the lean bushes could not furnish a sufficient amount of twigs to build them up in a single breeding-season." A possible and more reasonable explanation of the mounds is that pairs utilize the same *site* in successive years but probably not the same nest; the mounds, then, represent an accumulation of the nests of previous years. This explanation lends support to my belief that at least some pairs maintain territories throughout the year and that the pair bond is sustained or life long. I doubt that many nests at Half Moon Cay could survive the stormy season. Even by the end of my stay a few of the recently abandoned nests had nearly collapsed. Also the young birds usually left their nests to stand on perches long before they were fledged and, from there, tore their nests apart, piece by piece, until nothing was left of them. Eighty-one of 221 nests that were checked weekly had flying young by 9 May, and 74 per cent of these had removed their nests.

Nests were composed of small sticks, twigs, and coarse herb stems that were plucked with the leaves still attached. Thus nests frequently

had streamers of sticks with dry leaves hanging down from their rims as far as 500 mm. Of 27 nests, 24 were circular and three were slightly oval. The diameters of the circular nests ranged from 260 to 420 mm and averaged 306 mm. The diameters of the three oval nests were 480 x 340, 380 x 300, and 340 x 190. The outside depths of the 27 nests—top of rim to bottom of compacted portion of nest body and not including leaf streamers if such were present—ranged from 75 to 180 mm and averaged 113 mm. Nest depressions were shallow, rarely an inch deep; and nests became progressively more flattened after the egg hatched. In fact, some nests actually became convex on top as a result of the young boobies moving about on them and a lack of attention by the adults.

The birds tended to gather nest materials from areas where they could fly off into the wind. Twigs and small sticks were broken from the trees, and, on very windy days during the height of the construction period, coarse herbs were pulled up from the ground on the windward shore. The result has been a curious hedgelike shearing of the trees along the southern and eastern borders of the nesting colony, facing the direction of the prevailing winds. As one might guess from previous discussion, many nests were composed of materials that had been taken largely from abandoned nests.

TABLE 1

TREES UTILIZED AS NESTING COVER ON HALF MOON CAY

Species	*Total nests*	*Total trees*	*Av. no. nests/tree*
Cordia sebestena	783	363	2.16
Bursera simaruba	232	77	3.01
Bumelia retusa	210	130	1.62
Pouteria campechiana	86	45	1.91
Ficus sp.	50	25	2.00
Ximenia americana	22	7	3.14
Pithecellobium keyense	4	2	2.00
Neea choriophylla	2	2	1.00
Total	1,389	651	2.12

Eight species of trees were utilized for nesting cover (Table 1), and nest density was 312 per hectare (126.7 per acre). The nearest two nests in the colony were separated between their rims by only 17.5 cm.

Most nests were placed near the tops of the trees or on their outer edges where the birds could utilize winds or drop from their perches when taking flight. Nests were situated on top of criss-crossing net-

works of small branches that provided suitable platforms, in the angles of wide, flat crotches, or on top of nearly level limbs. Describing the nest of *Sula sula rubripes* at Moku Manu, Hawaii, Richardson and Fisher (1950) write: "The booby nests when first built consist of a handful of fresh branches, as of *Atriplex*, a foot or two long, bent or placed in a rough circle on top of a low bush. The booby packs these branches down, adds more branches, and bends the living bush down with its weight so that a rather flat, nesting platform results." Murphy (1952) remarks that the Red-footed Booby at El Fondeadero, Hermanos group, nests in trees and shrubs on the windward slope in order to have a good windward take-off.

The highest nest in the colony was 12 meters above the ground; the lowest was 1.8 meters, and the average height of 100 randomly selected nests was six meters. I found no record of higher nests in any part of the world. Apparently the nest height depends primarily on the height of available vegetation, and ground nesting is not unknown. On San Benedicto Island, in the Revilla Gigedo group, *Sula sula websteri* nests on grass culms from 0.3 to 0.6 meter high (Anthony, 1898; Beck, 1902; Kaeding, 1905; Hanna, 1926; and McLellan, 1926). At Jarvis Island, Kirby (1925) has photographed *Sula sula rubripes* nesting on piles of sticks 30 cm or more high. And Hutchinson (1950) writes that Hague mentions a booby (presumably *Sula Sula*) with that habit on Howland.

COPULATION

Copulation occurs at the territory, either on the nest or on a perch, but it probably never occurs at sea. Since the birds are rarely together at the territory during midday, copulation must necessarily take place either in the early morning or late evening. My observations indicate that it occurs most frequently in the evening, occasionally in the early morning, and rarely during midday. Copulation by nestless pairs has already been discussed.

Little or no preliminary ceremony preceded copulation, which usually occurred during periods when the male was gathering material for the nest. Occasionally, when returning with a stick, he landed directly on the female's back. The stick was passed to the female, who placed it on the nest. Then copulation followed. More often, the male landed beside the female. A stick-shake display followed, or the female placed the stick directly, and the male mounted. Just as he mounted, the male gave a loud, guttural, drawn-out screech. The female frequently raised one wing slightly, which served to lend support to the male. He put

his bill beside her neck, frequently shifting it from one side of her neck to the other but never taking her nape feathers in his bill. Then he slid backward over either side, sometimes flicking his tail from side to side just prior to cloacal contact and occasionally flapping his wings out to his sides slightly for balance. After the initial screech at mounting, the male began a series of low, guttural notes given at a rate of about 1 to 1.5 per second. Like the note accompanying the four-point, this latter note of copulation is best phoneticized as *walk*. But, unlike the four-point call, the copulatory note has a pronounced inflection in the middle. The series of notes continued until just after cloacal contact was effected and after the male had again assumed a standing position on the female's back. He remained standing there for various periods of time up to two minutes before hopping to a perch or flying off.

No female was ever heard to make a sound during copulation. However, on a very few occasions, I saw the female mount the male and remain a short time without attempting copulation. During those times the female gave part of the typical copulatory call of the male, and once one gave the full sequence of notes! Only nestless females were seen engaging in this activity.

Pair *22* copulated eight days before the female laid. I observed them copulating once each evening on the eighth, seventh, fifth, and fourth days before the egg appeared. The day before Female *22* laid, she remained on the nest all day, and Male *22* stayed in the colony gathering nest materials most of the day. Continuous observation of the nest was maintained from 0530 through 1830. I heard copulatory notes as I climbed to the observation platform at 0530, and when I got within view of the birds, Male *22* was standing on his mate's back. I am certain that they copulated. They copulated again at 0710, 0957, 1106, 1336, 1602, and 1812. When I left at 1830 Female *22* was asleep on the nest with her bill and head tucked back under her scapulars, and Male *22* was standing beside her.

The following morning the pair copulated at 0632 and 0653. The male was away from 0814 until 1652; in the meantime the female had laid. At 1722 and 1731 they copulated again. The next day the male incubated the egg, and the female was away until late in the afternoon. At 1812 they copulated once again, this being 31 hours after the egg had been laid. Illness halted my observations for six days; so I do not know how long Pair *22* continued to copulate after the egg was laid. Pair *72*, with an egg on their nest, copulated on the evening of 24 March. The date their egg was laid is unknown, but it hatched on the morning of 5 May. Calculations from determined incubation periods indicate that the egg may have been laid one and a half to five days before the last copulation was observed.

LAYING

By extrapolating from the date (1 April) on which the first flying young were seen, I have fixed the earliest date of laying at Half Moon

Cay that season at about 15 November. Eggs were still being laid up to mid-April, so the laying season for the colony extended over about five months. Courtship and nest building would extend the nesting season backward at least another two weeks, and there were still flying young returning to their nest sites for feeding on 18 September 1958 (Gilbert Saunders, *in litt.*). It therefore appears that the nesting cycle for the colony as a whole runs for about 11 months, and that the cycle for each pair lasts at least six months.

At the time of my arrival, there were wide differences among the pairs in respect to progress in nesting activities. Some pairs were still building while others had young well advanced. This pattern seems to be the rule in colonies of this species throughout its range, a striking example being that cited by Richardson (1957) for French Frigate Shoal in the Hawaiian Archipelago where the only six nests on the island show a range in laying time of "at least three and a half months."

Though I personally never found evidence that the Red-footed Booby lays more than a single egg per clutch, some published accounts state that two are occasionally laid. Some species of boobies lay two eggs (though it is said that only one of the young birds reaches maturity), and perhaps this has led some observers to attribute the same habit to the Red-footed Booby without evidence. No definite record of two *fresh* eggs having been collected from the same nest has been found. Belcher and Smooker (1934) reported that nests on Giles Islet, Tobago, held a single egg each, but that "two appears elsewhere to be the usual clutch." They fail to mention where this is true or how they obtained the information. Kirby (1925), writing of *S. s. rubripes* on Fanning Island, reported: "As has been repeatedly observed regarding these birds, two eggs are laid, but only one young comes to maturity." Kirby also fails to give the source of his information. Bent (1922) and Baker (1929) also report two eggs laid by some individuals, but again no reason is given for arriving at such a conclusion.

In two instances on Half Moon Cay nests were found to contain two eggs, but one of the eggs in each nest was obviously very old while the other appeared fresh. In each case only the fresher egg remained long in the nest. I once observed a booby take a darkly stained egg from its nest into its bill, toss its head back twice, and throw the egg to the ground. The remains of the egg showed no evidence that it had ever begun to develop. It is possible that the birds possessing the nests with one fresh and one apparently infertile egg were able to recognize the bad egg and got rid of it in a similar manner. In addition to the two nests containing two eggs each, 204 nests containing a single egg each and 311 nests containing a single young each were examined.

Eggs of the Red-footed Booby vary in shape from very long ovate to short ovate and are covered with a white limy substance that conceals the light blue or bluish-green shell beneath. Most eggs that were examined had a variety of scratches through the limy coat. Apparently the material is soft when the egg is laid, and the adult booby's

nails scratch through it to the shell. However, it is not easily marred after the material has hardened. A hundred eggs (different ages) were weighed and measured, and the results are summarized in Table 2. One abnormally small egg measured 49.3 x 34.9 mm and weighed 27.0 g. It had very little chalky covering and possibly lacked a yolk. Consequently, it was not included in the table of maximum and minimum measurements, though it was used in determining the averages. The measurements compare favorably with published records (Macgillivray, 1918; Gifford, 1913; Bent, 1922; Belcher and Smooker, 1934; and Fisher, 1903).

TABLE 2

EGG MEASUREMENTS

	Average	*Greatest*	*Least*
Length (mm)	59.4	*72.2* x 37.6	*53.3* x 40.0
Width (mm)	39.8	58.4 x *48.7*	61.9 x *36.7*
Weight (g)	47.1	58.3	35.0

Sula sula will relay if its first egg is destroyed; however, what percentage of the birds do so I do not know. Pair 1 relaid 27 days, Pair 2, 28 days, and Pair 22, 25 days after the loss of their first eggs. As noted before, Pair 22 deserted their territory enough during the daytime that neighboring boobies removed their nest. However, Pairs 1 and 2 maintained guard on their nests, so that they did not need to rebuild for the second nesting attempt. Richardson and Fisher (1950) reported that storms early in 1948 at Moku Manu, Hawaii, "largely destroyed the eggs and young of this species, and renesting was little attempted even by the end of April." The fertility rate, as determined by tracing the natural fate of 86 eggs and examining all eggs that failed to hatch, was 90.7 per cent.

INCUBATION

Incubation, begun very shortly after laying, required 42.5 to 46 days and averaged 44.5 days for the 12 cases. One pair of boobies incubated an infertile egg for 63 days before finally ridding the nest of it. Since but a single egg is laid per clutch, and since it was found that incubation began within a few hours after laying, determination of the incubation period was simple. I inspected a nest each morning and each evening until an egg appeared and arbitrarily assigned the time of laying as midway in the interval during which the egg was laid. Time of hatching was similarly fixed.

Both sexes incubated, and neither developed a brood patch. At 1112 on 12 March, Female 22 laid an egg. I recorded her movements carefully until she finally began incubation at 1346, just two hours and 34 minutes later. She remained on the egg until after I left at dark, and the male was on the nest at 0500 the following morning. Table 3 summarizes my observations regarding the proportions of total time spent in incubation and attention to the young by males and females.

TABLE 3

TIME IN HOURS AND MINUTES (HOURS/MINUTES) OF ATTENDING THE NEST

	Pre-egg	*Incubation*	*Nestling*	*Totals*
Male 21		39/03	57/27	96/30
Male 22	12/42	47/03	3/03	63/15
Male 23		44/05	31/12	75/17
Male 29		44/47		44/47
Male T39			35/45	35/45
Totals	12/42	174/58	127/54	315/34
Female 21		35/53	33/03	68/56
Female 22	40/51	48/07	3/25	92/23
Female 23		12/32	42/50	55/22
Female 29		58/56		58/56
Female T39			57/12	57/12
Totals	40/51	155/28	136/30	332/49

Apparently the sexes equally share incubation and attendance of young. But the female is at the nest more before the egg is laid than the male. She remains by the nest to perform the construction while the male gathers nest materials; and she spends up to three consecutive days on the nest just prior to, during, and shortly after laying. Although Table 3 indicates that only one pair was studied during the pre-egg stage, periodic observations were made also on two other pairs during their pre-egg stage, and these observations tend to support the conclusions drawn from Pair 22.

Incubating birds frequently held the egg between their feet with the inner web of each foot stretched around the egg. That is to say, they actually *stood* on their egg with the inner web and toe of each foot so that the inner toes nearly met on the upper surface of the egg. At times the inner toe and web of only one foot was stretched up around the side of the egg. The birds also incubated with both feet fully on the nest and the egg nestled among the belly feathers between the legs. At irregular intervals birds stood up for a few minutes, continuing to shade the egg, and then settled once more to incubate.

During the heat of the day the incubating bird sat, panted, or slept—sometimes with its head hanging over the edge of the nest. The egg was turned infrequently with the bill. Time was passed in such seemingly pointless activities as biting at small branches and leaves near the nest or by picking at the nest. I found that males and females alike would catch sticks that I threw toward them, often nearly tumbling off the nest in an effort to get sticks thrown out of their reach. All of the sticks that they caught were added to the nest, and males often performed the stick-wave display with their catch. The stretching of the wings backward and of the head and neck forward and "yawning"—gape opened wide, head frequently shaken—were common activities of birds on the nest. In another activity, the booby opened and closed its mouth two or three times in succession and usually elevated the maxilla independently (the naso-frontal hinge permits enough movement of the maxilla to separate the tips of the bill fully two to three cm) while contracting and relaxing the muscles in the gular area.

Throughout incubation the members of a pair saw little of each other except when one returned from fishing to replace the other on the nest. Frequently, after the female relieved the male at the nest, he spent some time gathering nest materials and bringing them back for her to place. I never saw adults feed each other at the nest. Apparently they go without food while actually incubating. The nonincubating partner usually roosted away from the nest. In cases that I observed, the night roosts were from three to eight meters from the nests of the pairs involved, and each pair had but a single night roost, although one perch might serve as the night roost for more than one pair.

My data indicate that each bird usually incubated for about 24 hours without interruption. Occasionally, a bird was replaced after only about 12 hours of incubation, and apparently, some remained on the nest for 36 and 48 hours without relief. Two exchanges were noted at the same nest during the same day only seven times in 648 nest hours of observation. In five of those cases, the exchanges occurred about 12 hours apart; in one case about seven hours apart, and in the last instance only 17 minutes apart.

Nest exchange, which usually occurred in the late afternoon or early evening, was simple and without ceremony. One bird flew in from its day of fishing, and the sitting bird immediately stood up and shifted to the edge of the nest or to a perch. The returning bird quickly took over at the nest, and its mate flew off. On a very few occasions the returning bird had to crowd the other off the nest. Assuming that 100 exchanges had occurred in a 24-hour period, they would have occurred

at a rate of 6.9 per hour between 0500 and 0700, 1.1 per hour between 0700 and 1500, 2.8 per hour between 1500 and 1700, 16.7 per hour between 1700 and 1900, and 5.5 per hour between 1900 and 0500. Many of the last exchanges certainly took place after dark. The records included pairs still incubating and pairs attending young; the general temporal pattern of exchange seeming to be the same in both cases.

CARE OF YOUNG

For the first few weeks of the life of the nestling, the adults shared the duty of continuous guarding. It was necessary at that time to shield the nestling from the sun; however, the necessity of this became less and less as the young acquired its thick coat of snow-white down. After a young was three or four weeks old, its parents ordinarily left it alone for a part of the day. As the nestling grew older, the adults tended to leave it *earlier* in the day, until, by about the 10th week, it was commonly left unattended for as many as 12 successive hours. Although the adults exhibited a tendency to leave their young earlier and earlier in the day, they seemed to return at about the same time each evening.

Feeding was by regurgitation, a process in which the adult opened its mouth and the young introduced its bill into its parent's throat. Maynard (1889) wrote the following concerning this species on the Cayman Islands: "The newly hatched Gannets are fed at first by true regurgitation, that is the fish eaten by the parents is converted into a peculiar glairy fluid which is given to the young. The old birds introduce the terminal portion of the bill into the mouths of their offspring and the liquid is literally poured down their throats. Later the fish is given to the young in half digested fragments and in the same manner. . . ." Perhaps adults do introduce their bills into the mouths of their newly hatched young to feed them; however, that they continue to do so in the same manner is certainly not the case, at least in the population that I observed. I observed the feeding of nestlings as young as five days, but I never saw any adult introduce its bill into its offspring's mouth. In 206 recorded feedings it was invariably the young that put its bill into the adult's mouth. Usually the adult lowered its head enough to allow the young to reach far back into its throat. Out of the 35 occasions that the sexes were distinguished, females were noted feeding the young during five more periods than males.

Feeding of the young was almost entirely confined to the evening; occasionally, it occurred in the early morning, but apparently only rarely during midday. Usually the adults fed their young almost im-

mediately upon returning from a fishing excursion, and the main mass of the feeding flocks returned in the evening. I recorded 0.26 feedings per hour between 0500 and 0700, none between 0700 and 1500, 0.78 per hour between 1500 and 1700, and 3.04 per hour between 1700 and 1900. From dawn to dark on 26 April, I observed and recorded the activities of 13 pairs with young, and the first feeding noted that day occurred at 1748. Although midday feedings were not observed, they must have occurred. Two young birds were repeatedly weighed in the morning and evening; in 23 such pairs of weighings an increase in weight during the day was noted on three occasions.

There seemed to be only one feeding period per day, usually in the evening as noted above, for each young. There may be more in some cases, but this was never observed. The young were frequently fed several times and sometimes by both parents during one feeding period. Both adults fed their young during the same period only after the nestling was old enough to be left alone for part of the day, so that both could return to the nest from fishing at approximately the same time. In most cases the young was fed five or fewer times per feeding, although in an extreme case a female fed her offspring 16 times in 20 minutes. The young had been weighed just before the feedings so it was weighed again immediately after. The increase was 62.9 g, 31 per cent of the body weight (202.5 g).

"False feedings" were frequent and seemed to be an incomplete response on the part of an adult to the agitation of its hungry young. During false feedings, the adult did not lower its head; therefore the young could get its bill only to the back of its parent's mouth. The adults did not gulp after false feedings as they did after genuine feedings, since no food had been passed and nothing remained in the throat to be swallowed.

Young boobies continued to depend on the parents for food long after they were able fliers. One juvenal that had been flying for a month before I left the colony was still returning to the old nest site each evening to receive food from its parents. In one extreme case, a juvenal from the previous nesting season—certainly nearly a year old—was being fed by one member of a pair that had a nest directly behind the observation platform. The feeding was observed only once, but I suspected it had occurred several times before that. The juvenal flew in to land beside the old bird's nest nearly every evening, and even after their nest was broken up and the adults deserted the territory the juvenal continued to return. It was after the loss of the nest that the feeding was noted; thus the adult involved had to return to the original

territory. It did so just long enough to feed the younger bird. How long young must depend on the adults for food was not determined.

DEVELOPMENT AND ACTIVITIES OF YOUNG

Pipping of the egg occurred up to a full day before hatching. Every hatched egg that I examined had the blunt end removed as a cap. Apparently, the adults simply dropped the pieces of the shell over the side of the nest. Newly hatched birds had pinkish flesh-colored skin with a dark gray or bluish-black area on the dorsum over the synsacrum. The eyelids and face were dark gray to grayish-brown. The bill was blackish-brown, and the feet and legs were flesh-colored. The eyelids were closed, though slit for about three millimeters, and the irides were pearly gray. All feather tracts had ensheathed down. That on the back and on the alar and caudal tracts was not over two millimeters long, and the remainder was not over one millimeter long.

The color of the skin darkened gradually to gray, and by the time the young was eight days old only the neck was still slightly flesh-colored. Also by the eighth day most of the down had "bloomed" from the sheaths, and the young appeared *sparsely* down-covered. However, the birds were about two weeks old before they had enough down to give them any protection, and even then many areas were still virtually naked. My notes on the plumage on one 18-day-old booby read "completely down-covered, though only sparsely on the throat and behind the eyes."

When a young was hungry it went through a regular routine of display before the adult that began with an incessant series of short notes that sounded like *awp, awp, awp, awp*. The young bird doubled its neck up and held it back so its chin rested on its neck. In that position it rocked its head from side to side while *awp*-ing and occasionally flailing its wings out to either side. Finally it began to jab at the pink base of the adult's bill in a similar action to that of young gulls. The adult booby responded either by turning its head away or by opening its mouth and feeding the young. Sometimes a nestling simply *awp*-ed and jabbed at the adult's bill, and sometimes the adult fed the young without any prompting. Young boobies that I fed for several days performed precisely the same feeding display before me as soon as they saw I was walking toward them.

When they were awake, nestlings sat on the nest and panted, fought with small branches and leaves by the nest, or flopped their wings around and bit at their own wrists. They would catch sticks thrown to them or try to take the sticks the male brought in to be added to the

nest. They also jabbed and bit at the wings and tails of their parents. When they slept they either curled up on one side, laid on their stomach with their wings and neck stretched out to hang where they might, or placed their feet slightly apart on the nest and leaned forward to come to rest on top of their head with their bill directed backward toward their belly, thus forming a nice tripod!

Young began exercising their wings long before they could fly. Their first attempts at flight were mainly extended hops on outstretched wings, and they usually strayed far from the home territory during such trials, frequently passing through other territories and being beaten away by attending adults or young. They became fully capable of flight before they lost all their down, and some were seen flying around with down still clinging to the sides of the neck and the top of the head. Down persisted longest on the forehead, and the brown juvenals carried this mark of their age for several days after they were capable fliers.

My notes on the development of young Red-footed Boobies are incomplete, since the period required to attain juvenal plumage is greater than the 12 weeks that I was in the colony. In fact 14 of the 221 nests traced throughout the study had young on the nest when I arrived that still were not through the postnatal molt and could not fly when I left. Through the cooperation of Gilbert Saunders (*in litt.*) I obtained information on eight nests from the time of laying until the young were fledged. Three required 13 weeks, four took close to 15 weeks, and one took 16 weeks from the time of hatching to the time of fledging. The first three hatched the last five days of April, the others during the first 13 days of April, indicating that the young may develop more rapidly if they hatch near the end of the nesting season.

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SUMMARY

The nesting activities of a colony of Red-footed Boobies in British Honduras were studied for three months.

The "four-point," "stick-wave," and "stick-shake" displays appear to have a role in formation and maintenance of the monogamous pair bond, which is probably sustained or life long.

Apparently, the male selects the small territory, which is used for nesting, copulation, and sometimes roosting. The stick-wave may play a part in territorial selection. Territorial defense is by threat display, principally the one-point, or physical contact. Nestless pairs maintain territories for at least two months.

Apparently the female initiates nest construction, after which the male gathers all materials while the female places them in the nest. Nests are added to even after the egg hatches, and the lining is changed during incubation. Nest materials are taken from vacant nests, from trees, and occasionally from the ground. Nests were placed in trees where the birds have access to wind currents; their height appears to depend on the height of available vegetation.

Copulation was noted only on the territory and occurs most often in the evening. It is preceded by little or no ceremony and occurs as much as eight days in advance of laying and as frequently as seven times on the day prior to laying. It is continued for a short period after laying. One nestless pair copulated regularly for at least a month.

Laying begins in mid-November and extends to mid-April; there is a single egg per clutch. Relaying occurred. Fertility rate was 90.7 per cent.

Incubation begins shortly after laying and is shared about equally by the sexes. The mean incubation period was 44.5 days. Exchange usually occurs in the evening; the incubating bird usually sits for 24 hours without relief or food.

Adults shield the young for a time, but after they are three to four weeks old they are left alone for part of the day. They are fed by regurgitation by both adults during a single feeding period per day, usually in the evening.

The young at hatching are helpless, with pinkish flesh-colored skin and ensheathed down on all tracts. Development is slow, and the young continue to depend on adults for food long after they are able to fly. One bird nearly a year old was seen receiving food from a nesting adult. Shortly before they can fly, most young dismantle their nest and spend the remainder of their "nestling" period on a perch.

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THE SONGS AND CALLS OF THE WOOD THRUSH

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THE song of the Wood Thrush *(Hylocichla mustelina)* is long-continued, and made up of phrases with comparatively long pauses between them. Each of these phrases is composed of up to three parts, differing from each other in quality and loudness. The parts are the introductory phrase, the main central phrase, and the termination. A bird may sing a phrase containing all three of these parts or omitting any one or two of them. The one most commonly omitted is the introductory phrase. The phrase most rarely omitted is the central phrase. This central phrase is the loudest, clearest, and most musical part, and from a distance often the only phrase heard.

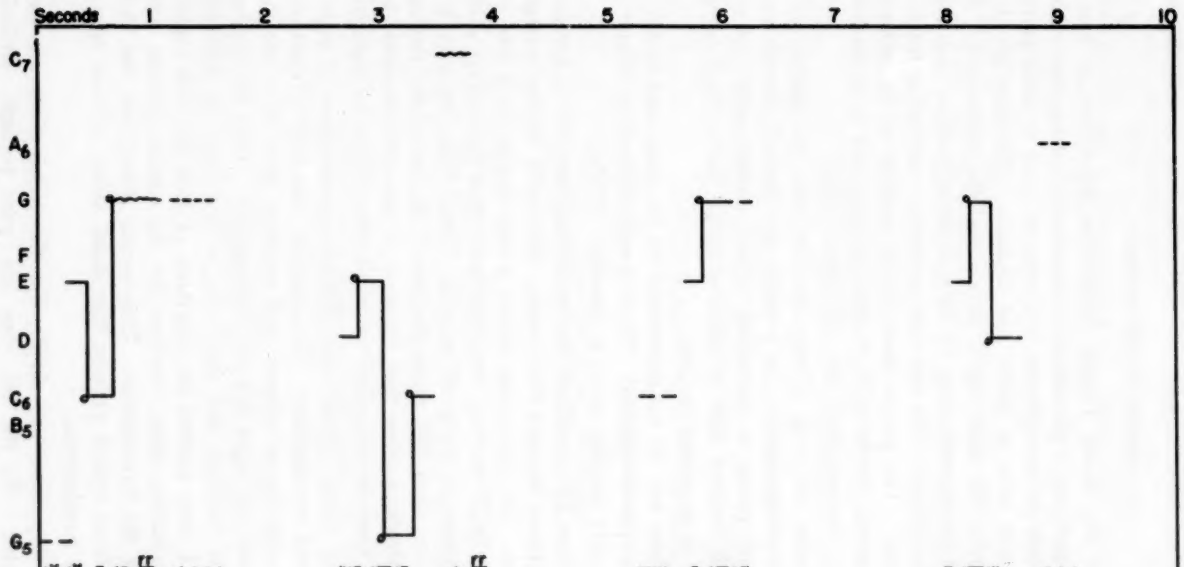
While I consider this song a long-continued one, the matter may have a different interpretation. In a recent publication (Borror and Reese, 1956) each phrase is considered to be a distinct song, and an individual bird is credited with 10 different songs, five of them being what I consider to be central phrases.

If there are those who do not understand the diagrams used in illustrations, these have been explained. The first explanation is in Saunders (1915), and a more detailed one is in Saunders (1929).

The song (Figure 1) is a difficult one to illustrate just as it is, because of rather long pauses between the phrases, that would require a large amount of space. The illustration shows a bird singing at a rate of about 10 phrases in 24 seconds, somewhat faster than the average song of nearly 10 phrases in 38 to 40 seconds. Some birds are very irregular, and slower than this, especially toward the end of the singing season. In illustrations other than Figure 1, I have not attempted to show the actual time, for altogether too much space would be required.

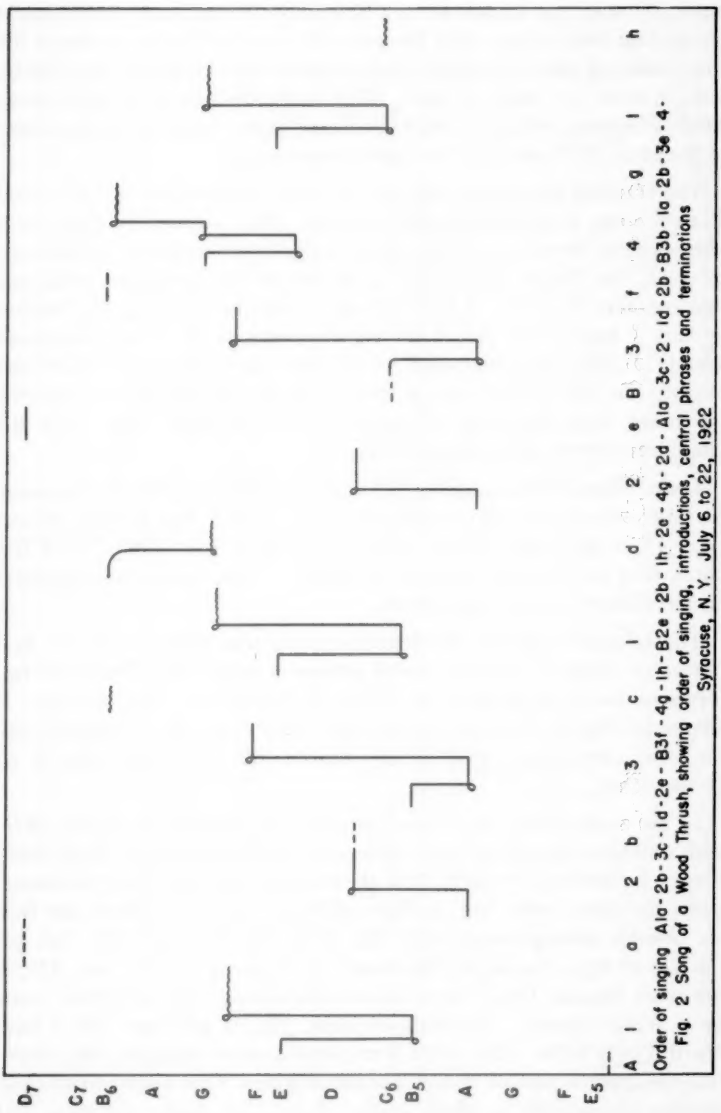
In singing, the Wood Thrush uses different combinations of introductory notes and terminations. For example, one bird (Figure 2) sings four different central phrases, and combines these with two introductory phrases and eight different terminations. Thus the singing of 24 phrases is recorded, and there are, in that time, 15 different combinations. I have labelled the diagrams (Figure 2) with capital letters for introductory notes, numbers for the central phrases, and small letters for the terminations. This record shows how the bird may sing occasional central phrases that stand alone, without either introductions or terminations.

The introductory notes are simple, but the terminations are exceedingly complex. To the ear they are quite perfectly pitched,



Central phrases (numbered and underlined) clear, loud, flute-like. Introductions (Capitol letters) guttural. Terminations (small letters) sibillant.

Fig. 1 Portion of the Song of a Wood Thrush, illustrating introductions, central phrases, terminations and time of singing. Fairfield, Conn. June 11, 1921



Order of singing A1a-2b-3c-1d-2e-B3f-4g-1h-B2e-2b-1h-2e-4g-2d-A1a-3c-2-1d-2b-B3b-1a-2b-3e-4-

Fig. 2 Song of a Wood Thrush, showing order of singing, introductions, central phrases and terminations
Syracuse, N.Y. July 6 to 22, 1922

musically often just an octave, or a fifth above the last note of the central phrase that they follow. But Borror and Reese (1956) have shown the complexity of these terminal notes, wherein the bird may sing three, four, or even five notes at once. They range high in pitch, even above 8,000 vibrations, which is about an octave higher than the highest note of the piano, and above the hearing of many people.

The study of the central phrases, the most musical part of the Wood Thrush song, is of considerable interest. The number of notes in a phrase varies from one to 10. In my records the variation is from one to seven, but Borror and Reese, by means of the vibralyzer, show one that contains 10 notes. I have wondered whether, hearing this phrase by ear, I would have heard the middle notes as an L-like consonant sound. If that were the case I would have recorded it as a seven-note phrase. In any event I am writing from the standpoint of what the ear hears, and that may be more or less different from what the vibralyzer records (Saunders, 1959).

I have recorded the songs of 179 different individual Wood Thrushes. In these records are 583 central phrases. I have two phrases of one note, 43 of two notes, 428 of three notes, 90 of four notes, 14 of five notes, four of six notes, and two of seven. Thus nearly three-quarters of the phrases are of three notes.

The one-note phrases are represented in the diagrams in the first phrase of Figure 7 and the second phrase of Figure 8. There are two forms of two-note phrases, as shown in Figure 13. One of these is shown in Figure 2, phrase 2. Actually this one is less common than the other form, there being, in my records, only 11 of this form to 32 of the other.

In the study of the three-note phrases it is simplest to classify them with numbers, according to the differences in pitches of the three notes. I use 1 for the highest pitch, 2 for the medium one, and 3 for the lowest, when the three notes are on three different pitches. There are then six possible arrangements: 123, 132, 213, 231, 312, and 321. All but the last of these forms are illustrated in Figure 14. The last, 321, is not there because I have never heard this arrangement of pitches sung by a Wood Thrush. The first of these, 123, is also rare, for I have heard it only twice. The other four phrases occur regularly and constitute the greater part of Wood Thrush singing. One might write these phrases phonetically as *eelola, alolee, aleelo,* and *oleela.* Of these, 231 or *alolee,* is the commonest phrase of all, constituting more than 50 per cent of these three-note phrases. Arrangement 132, or *eelola,* makes

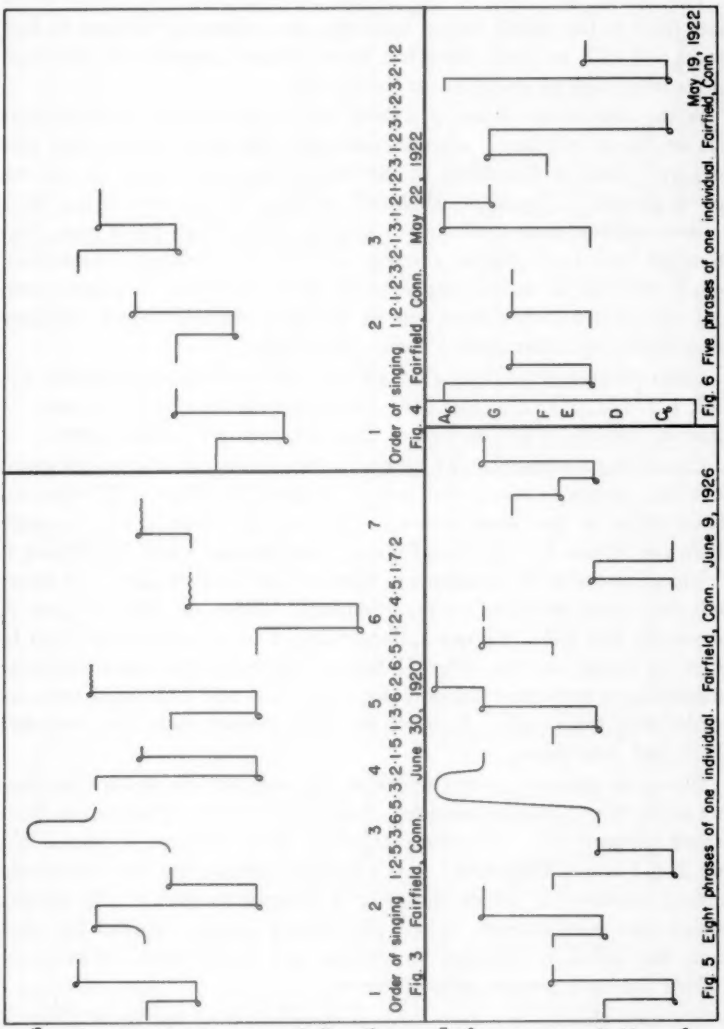


Fig. 5 Eight phrases of one individual. Fairfield, Conn. June 9, 1926.

Fig. 6 Five phrases of one individual. Fairfield, Conn.

up about 25 per cent, and the remainder is almost equally divided between the other two.

The lack of such a phrase as 123 and the greater rarity of those forms with the 1 in the middle are an indication of a condition common in bird songs and calls in which there is a much greater tendency for the pitch to go from high to low than for the reverse.

In the case of the phrase 312 there occurs occasionally a phrase that has no liquid consonant sounds connecting the notes and sounds like *oweeay*. This is illustrated in the third phrase of Figure 3 and the fourth phrase of Figure 5. Eighteen, or about 10 per cent of the birds I have studied, have used such a phrase. I thought, for a time, that it might be a local phrase, common to birds in southern Connecticut, but 17 records of such a phrase come from 106 birds in Connecticut, and one record comes from one of 12 birds recorded from Allegany State Park, in Cattaraugus County, New York.

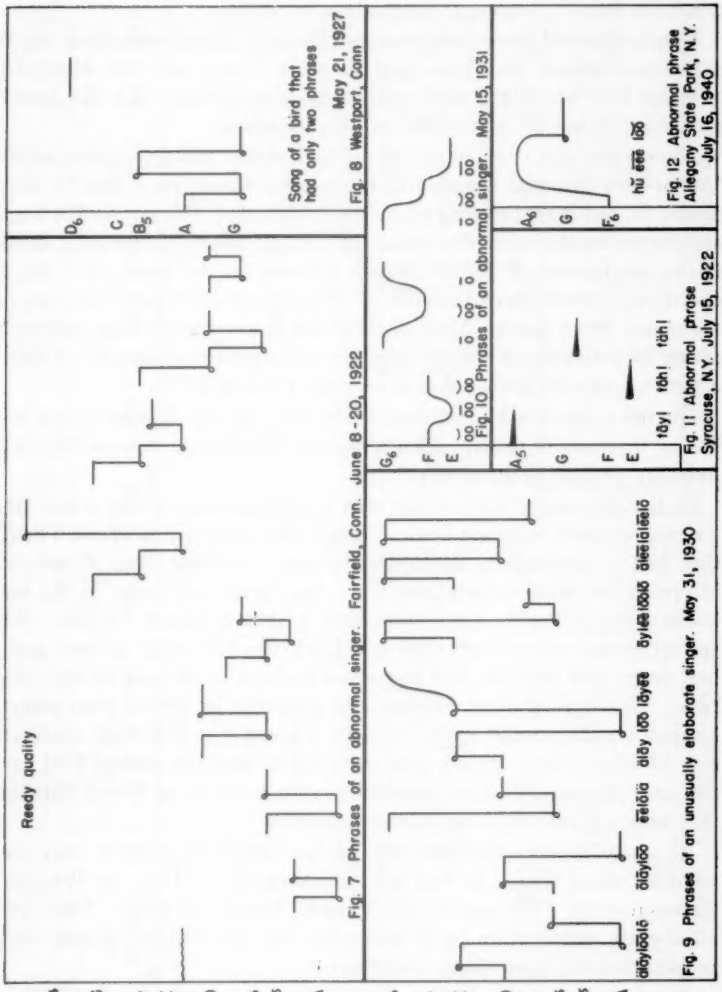
Other three-note phrases that are on only two different pitches are 112, 121, 122, 211, 212, and 221. These are not especially common. I have 20 records of 211 and 14 of 212, but very few of the others.

Classifying a phrase as 231 or some other arrangement does not mean that that phrase is always the same. I have 24 different 231 phrases. They differ in the pitch intervals between the notes. For example there are phrases 1, 5, and 6 in Figure 3, and phrases 1 and 2 in Figure 4.

I have recorded 25 variations in form of four-note phrases. Of these, only two might be called common phrases. These are 2321 (Figure 2, phrase 4) and 2143 (Figure 1, phrase 2). I have recorded the first of these 20 times, and the other 21 times. Eleven of the other four-note phrases have been recorded only once, but 2113 and 3421 have been recorded four times each. Some of the other phrases have been recorded three and two times.

Five-note phrases are not common, the majority of Wood Thrushes not using them. I have recorded 14 different forms. Twelve are illustrated (Figure 17). Of others 21314 is shown (Figure 9, phrase 6), but 21212 is not illustrated. It is a peculiar phrase, the bird sometimes adding another 12, which makes it a seven-note phrase. It usually sounds like *oolayoolayoo*. These phrases are mostly recorded but once each, but 43512 is recorded four times, and 32421 twice. I have recorded five-note phrases only 18 times.

Six-note phrases are very rare. I have recorded but three (Figure 18), each heard from a single bird. One of them, the third phrase, has been heard many times, for the bird lived in my yard for two successive summers, and that phrase, with a drop of an octave, marked it definitely.


Reedy quality
Song of a bird that had only two phrases
May 21, 1927
Fig. 8 Westport, Conn
Fig. 7 Phrases of an abnormal singer. Fairfield, Conn. June 8-20, 1922
Fig. 10 Phrases of an abnormal singer. May 15, 1931
Fig. 11 Abnormal phrase Syracuse, N.Y. July 15, 1922
Fig. 12 Abnormal phrase Allegany State Park, N.Y. July 16, 1940
Fig. 9 Phrases of an unusually elaborate singer. May 31, 1930

The bird often sang within five meters of our screened porch, and had a habit of sitting in the bird bath and singing. It also perched on a certain hickory limb that slanted slightly downward, and slid slowly down the branch, singing at intervals as it did so.

I have recorded seven-note phrases twice, one mentioned above where a five-note phrase was prolonged to seven notes, and one illustrated (Figure 19) where the bird used a five-note phrase, like the second phrase in Figure 17, and added two higher notes.

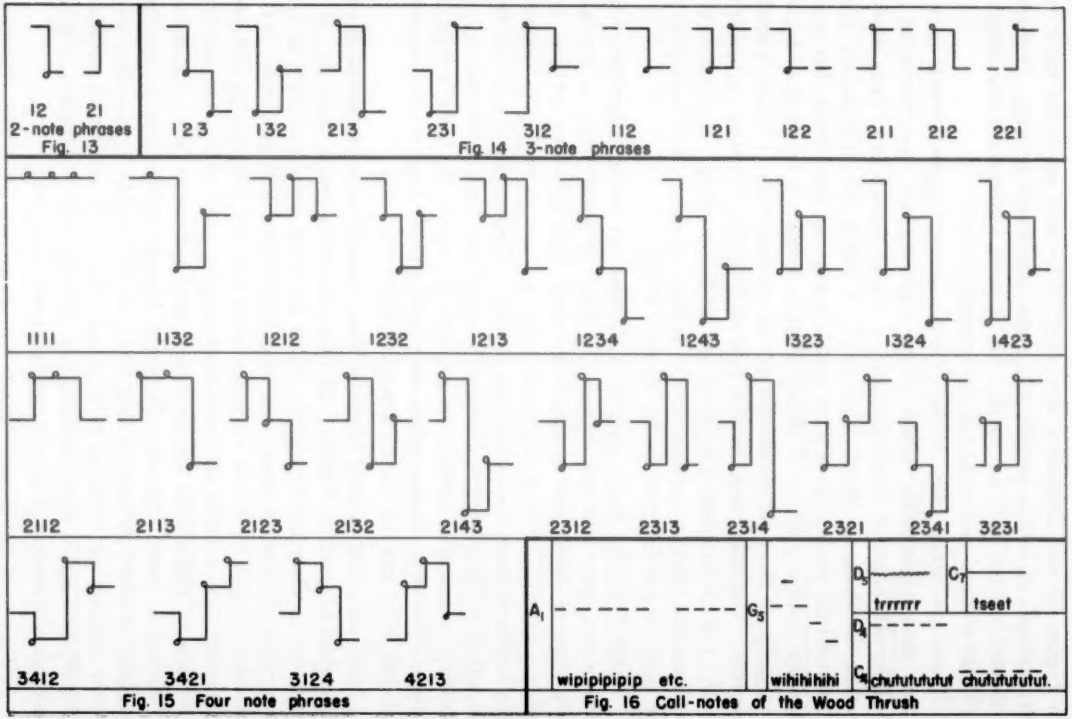
Some years ago a boy in one of my high school biology classes asked: "What bird is it that sounds like bugle-notes played on a flute?" Evidently he had been listening to a Wood Thrush. The notes of a bugle are always on the notes that make up a major chord, *do mi sol*. While by no means are all Wood Thrush phrases on the notes of a major chord, my records show that 109 of 580 phrases (18.6 per cent) are on the major chord notes. Most of these are three-note phrases, and eight of the 24 variations of the 231 phrase are on the major chord. A fairly common four-note phrase that is on these notes is 2321.

On the other hand occasional birds sing off the diatonic scale and flat or sharp some notes. Such is the case in the last note of the sixth five-note phrase (Figure 17).

In the very early days of my bird activities, when I was a boy first learning to know common birds, I heard, day after day, a Wood Thrush that had a particularly impressive phrase. At the time I had not identified the bird, so indefinite were descriptions of songs in the bird books. But I finally determined that it was a Wood Thrush. The special phrase was a four-note one 1212, the two notes a tone and a half apart, and the first and last notes each twice as long as the other two. This was at New Haven, and probably in 1898. For years I listened for this phrase again. Finally I heard it at Fairfield, Connecticut, 13 May 1928. Was it just an accident that the second bird sang the same phrase, or is there something in the heredity of Wood Thrushes that brings it out in an occasional individual?

In a similar way the four-note phrase, 2313 (Figure 8) has been recorded three times: in Fairfield, Connecticut, in 1920, in Westport, Connecticut, in 1927, and in Mt. Vernon, Illinois, in 1950. They were all slightly different in pitch intervals, and the Illinois record, lower in pitch but the same form, was there.

There occur, occasionally, certain peculiar phrases in individual Wood Thrushes. These are often nonmusical, or less musical than normal phrases. Such birds will have other phrases that are perfectly normal (Figures 11 and 12). The bird in Figure 7 was not a good singer,


12 21
2-note phrases
Fig. 13
123 132 213 231 312 112 121 122 211 212 221
Fig. 14 3-note phrases
1111 1132 1212 1232 1213 1234 1243 1323 1324 1423
2112 2113 2123 2132 2143 2312 2313 2314 2321 2341 3231
3412 3421 3124 4213
Fig. 15 Four note phrases
A1
G5
wipipipipip etc.
wihihihihi
D5
C7
trrrrrrr
tseet
D4
C4
chutututututut chutututututut.
Fig. 16 Call-notes of the Wood Thrush

and its song was not normal. The bird in Figure 9, however, was extremely musical, and its phrases were unusually elaborate. The song in Figure 10 was altogether abnormal. The bird made me think of the attempts of certain people, who were monotones, to sing. Perhaps this bird had no "ear" for music. So we have in these unusual singers both the musical monotone and the musical genuis.

There are times when Wood Thrush songs suggest human music other than bugle calls. Once, when a phonograph was producing a well-known piece of classical music, a friend remarked: "That music makes me think of Wood Thrushes." I noted the resemblance and examined the music. In it were certain groups of three notes that were like the central phrases of Wood Thrush songs. I found that I had duplicates of those three-note phrases in my collection of Wood Thrush records. The music was the first part of Rossini's *Overture to William Tell*. I once demonstrated this at an A.O.U. meeting. Evidently certain musical phrases appealed to the human composer that happened to be more or less inherent in the Wood Thrush.

Wood Thrushes begin singing with their arrival in migration. In southern Connecticut this is about 1 May; in some years in the last few days of April, and in others not until May has been with us for several days. The song continues with us through the early summer but begins to wane toward the end of July. Figures that I gave for the cessation are now slightly changed by data later than 1946 (Saunders, 1948a). General cessation now averages 3 August, the latest 9 August 1948. The date of the latest song averages 7 August: the earliest 21 July 1949 and the latest 19 August 1948.

Data on revival of song have not been changed so far as my observation goes (Saunders, 1948b). Mention should be made, however, of a remarkable observation (Hazen, 1928) in which a flock of birds in fall migration alighted in trees on a moonlight night in Washington, D.C., at 2200. Some 10 Wood Thrushes burst into full song for 20 minutes, and after that a single bird continued singing until 0245. Considering the time of night, such an occurrence may not be as rare as this one observation would indicate. It might happen more often in wooded regions, unheard by man at that hour, or only heard by someone who knew nothing of birds or bird songs. But if a similar observation should come again from someone who knows, and is prompted to publish his observation, I should not be greatly surprised.

Call-notes of the Wood Thrush are shown in Figure 17. The loud *pipipip* is used frequently, on one occasion repeated 25 times in succession. It is used as an alarm note when the nest or young are threatened,

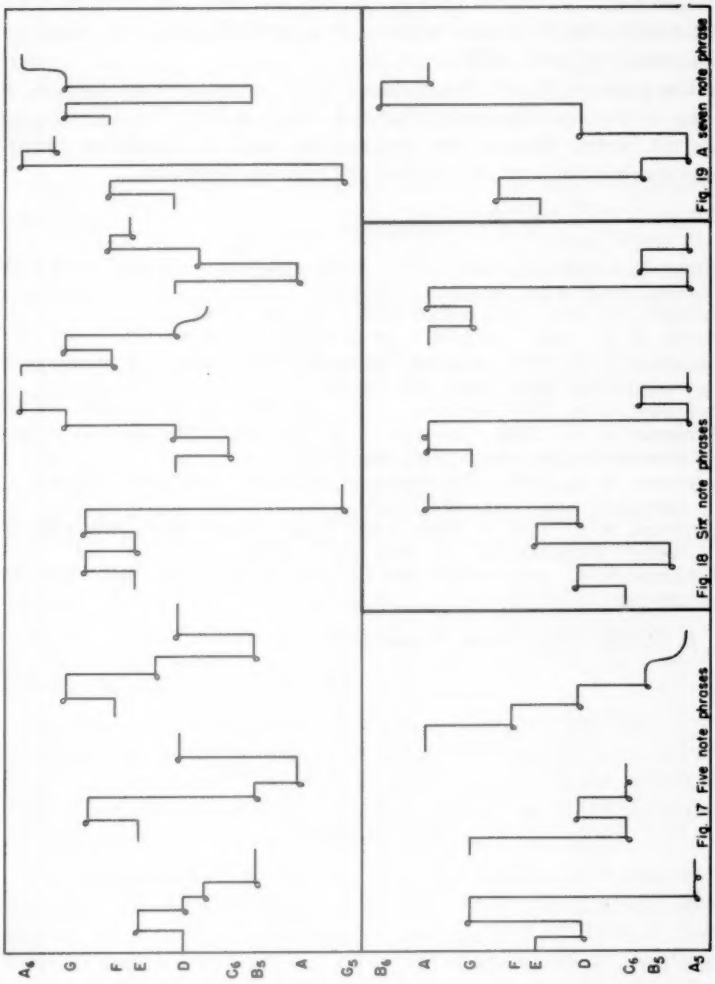


Fig. 17 Five note phrases

Fig. 18 Six note phrases

Fig. 19 A seven note phrase

and I have known it to be used when a Wood Thrush and several other kinds of birds were engaged in teasing a Screech Owl *(Otus asio)*. The high-pitched *tseet* call I heard on but one occasion, when a bird was hunting food on the ground. It was not loud, and perhaps I had not noted it before because of that. It is probably used as a sequestration note (Grinnell, 1920).

The pitch of Wood Thrush songs in my records varies from E_5 to $D\#_7$. Call notes range lower than this, reaching D_4. The highest notes are not central phrases, but terminations, and the vibralyzer records indicate that they are higher than the ear can determine.

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BURFORD LAKE, NEW MEXICO, REVISITED

WILLIAM S. HUEY AND JAMES R. TRAVIS

IN 1918 a comprehensive ornithological survey was conducted at Burford Lake by Dr. Alexander Wetmore (*Auk*, 37:221-247, 393-412, 1920). In March 1960 Dr. H. Albert Hochbaum suggested that a resurvey of the area, comparing present conditions with those recorded by Dr. Wetmore 42 years ago, might be of interest. The present paper is a report of such a resurvey.

The Burford Lake area of the Jicarilla Apache Indian Reservation has been included in a survey of waterfowl production in northwestern New Mexico for the past three years, as a contribution to the New Mexico Department of Game and Fish waterfowl investigations project. Some data collected for this project during the years 1958 and 1959 are also included in this account.

We were accompanied by George W. Merrill and Roy E. Tomlinson, of the New Mexico Department of Game and Fish, and were later joined by Mrs. James R. Travis.

The survey was planned as a part of the annual waterfowl study mentioned above; because of other activities it was limited to a one-week period. For purposes of comparison with the original survey the dates of 6 to 12 June were selected as most nearly approaching the peak of activity of Dr. Wetmore's four-week visit. The progress of the season upon our arrival indicated that this selection had been appropriate. Also included in the report are data relating to waterfowl production and summer visitors and data collected during duck-banding activities from 18 to 21 July 1960.

Stone Lake, Embom Lake, and Horse Lake are included in the discussion and the annotated list of birds. This was done so that any shift in waterfowl use, caused by a deterioration of habitat quality on Burford and Thompson lakes, may be accounted for in complementing Dr. Wetmore's work as completely as possible.

The cabin described by Dr. Wetmore and used as his headquarters exists now only as two deteriorating adobe walls. Through the kindness of the Jicarilla Apache Agency and the U.S. Bureau of Sport Fisheries and Wildlife, we used as a base of operations the headquarters of the Burford Lake Wildlife Area, located approximately three km (two miles) west of Burford Lake in a sparse but mature stand of ponderosa pine *(Pinus ponderosa)*. A small pond formed by the overflow from a windmill at this location supplied an opportunity to

observe, at close range and with a minimum of travel, most of the passerine species that inhabit the pine-clad hills surrounding the lake.

To supplement field observations, trapping and banding of small land birds, using 10-meter, 4-trammel, 1-inch mesh, Japanese mist nets, was conducted at four typical locations near the lake. The following is a list of these banding sites, with the number of net hours noted:

1. Small pond near headquarters, 215 net hours in June, and 46 net hours in July.
2. Hayden Lake shoreline, 187 net hours in June.
3. Sagebrush flats near the north shore of Burford Lake, 32 net hours in June.
4. Spring in cottonwood grove described by Dr. Wetmore and pictured in Figure 3, 50 net hours in June.

During 530 net hours, over an eight-day period, 300 individuals of 27 species were banded. These records are included in the annotated list by species.

PHYSICAL FEATURES AND GENERAL CONDITIONS

The physical features of the area, as noted by Dr. Wetmore, have changed little during the past 42 years. As nearly as can be determined from his descriptions and from the photographs included in his text, the water levels of the lakes in 1960 are comparable to those of 1918. This similarity is due to a whim of nature, not to stability, as the annual variation is often quite pronounced. For the benefit of the reader to whom Dr. Wetmore's work is not available, a brief description of the lakes and the surrounding terrain is here included.

Burford Lake is located in northern Rio Arriba County of New Mexico on the Reservation of the Jicarilla Apache, near the Continental Divide at an elevation of about 2,300 meters (7,000 feet). To the east is the Chama River, a drainage of the Rio Grande, and to the west is the San Juan River, a drainage of the Colorado. Burford Lake is the largest natural impoundment in New Mexico, and at this time contains approximately 800 hectares (2,000 surface acres), two to three meters in depth—a water level that is about average or slightly above. The lake is constricted at its center by sandstone ridges so that the open, northern end is almost separated from the more-protected, southern end. During the early spring, lack of protection from the persistent west wind causes the northern portion to become quite turbid due to the incessant wave action on the unprotected silt bottom. As the season progresses, however, the intensity of the wind decreases and allows the growth of sago pondweed *(Potamogeton pectinatus)* to cover the lake's surface almost completely. In the southern end of the lake the water is less turbid, and sago pondweed is quite abundant.

The dense growth of roundstem bulrush *(Scirpus occidentalis)*, described by Dr. Wetmore as nesting cover on the east side and south end of the lake, is much reduced. During the drouth of the early 1950's, and we may assume also during the 1930's, these rushes were left high and dry by the receding shoreline. Lack

Figure 1. The narrow center portion of Burford Lake. This photograph was taken about 100 meters south of the point from which photograph 1, plate 8, in Dr. Wetmore's work was taken. The pronounced reduction in emergent vegetation may be noted by comparing these two photographs.

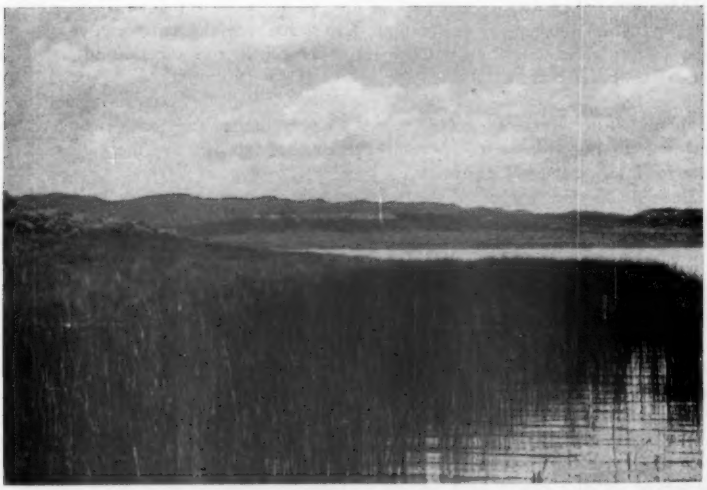


Figure 2. The emergent aquatic vegetation is becoming reestablished after being reduced by drouth and overgrowing.

of moisture, coupled with intense grazing by cattle and horses, so weakened these stands that their recovery at this time is just beginning. At any rate, their sparseness during the past few years has afforded nesting cover to only the very late nesters.

The black and gray willows mentioned by Dr. Wetmore have evidently been completely destroyed as shoreline vegetation, since none are now to be found around the lake. Large trunks of cottonwood (*Populus* sp.) may be found lying around the shore, but only small, broad-leaved cottonwood (*Populus wislizenii*) are growing here. Thus, we may confidently assume that the shoreline flora is only now recovering from severe drouth. Substantial amounts of three-square (*Scirpus* sp.) are becoming established on the north and west sides of the northern portion of the lake.

One vegetative factor not mentioned by Dr. Wetmore is a good stand of smartweed (*Polygonum* sp.) located at the southwestern end of the northern section of the lake. The smartweed is host to small aquatic organisms, and its seed makes this species quite valuable to waterfowl.

Hayden Lake, a long, narrow impoundment lying about 300 meters east of Burford, covers perhaps 40 hectares (100 surface acres) and is about two meters deep. The central and southern portions are surrounded by dense stands of roundstem bulrush, which we imagine compare to those described by Dr. Wetmore on Burford in 1918. The value of this growth is supplemented by sago pondweed and smartweed to make this small lake quite attractive to the area's bird life. An inspection of the rushes revealed 43 coot nests that contained eggs, ranging from incomplete clutches, to one in which there were two newly hatched young. The nests of one Black-crowned Night Heron and one Pied-billed Grebe were also found in the same area. Although an exact count was not made, it was estimated that 100 nests of Yellow-headed Blackbirds occupied the rushes also.

Thompson Lake, often referred to as Laguna de la Puerta, into which Burford Lake overflows during extremely high water, has for the past few years been quite low to nearly dry and consequently very little use for nesting has been made of it by water birds.

Stone Lake, 11 km (seven miles) north of Burford, a natural impoundment of about 240 hectares (600 acres), is put to only limited use for breeding waterfowl due to the absence of shoreline vegetation, but is quite heavily used by waterfowl during the fall migration.

Horse Lake and Embom Lake are artificial impoundments 11 km north of Stone Lake. Horse Lake impounds about 80 hectares (200 surface acres) and Embom about 16 hectares (40 surface acres). These two lakes are quite similar in water quality, being considerably less alkaline than the four previously described.

Reference will be made in the annotated list to Apache Mesa. This mesa rises to the east of Burford Lake to a maximum elevation of about 2,700 meters.

The vegetative types described by Dr. Wetmore remain practically unchanged. Sagebrush (*Artemesia tridentata*) continues to dominate the landscape of the rolling hills surrounding the lakes. Saltgrass (*Distichlis stricta*) and foxtail (*Hordeum jubatum*) are common shoreline grasses. Another grass quite common in the area now, but not mentioned by Dr. Wetmore, is cheatgrass (*Bromus tectorum*). At the higher elevations around the lakes these species are replaced by pinyon (*Pinus edulis*) and juniper (*Juniperus monosperma*), with patches of Gambel oak (*Quercus gambelii*) on the open hillsides, and currant (*Ribes* sp.), chokecherry (*Prunus* sp.), and serviceberry (*Amelanchier* sp.) on the better-

Figure 3. The grove of narrow-leaved cottonwood *(Populus angustifolia)* described by Dr. Wetmore is still in existence, and was used as banding site No. 4 during the 1960 survey.

Figure 4. Hayden Lake located east of Burford Lake is host to a substantial stand of roundstem bulrush *(Scirpus occidentalis)*. These rushes were used extensively by nesting coots during the 1960 survey period.

watered, more-protected areas. Above the pinyon-juniper is typical ponderosa pine bench country with an understory of the above-mentioned, deciduous species. Douglas fir is common on the north-facing slopes within three km of Burford Lake.

The mule deer is a common resident over the entire area, as are coyotes, skunks, badgers, porcupines, cottontails and jackrabbits. The wolf mentioned by Dr. Wetmore has long since departed from all of northern New Mexico. One colony of beaver now inhabits the southeastern portion of Burford Lake, and muskrats were seen in both Burford and Hayden lakes.

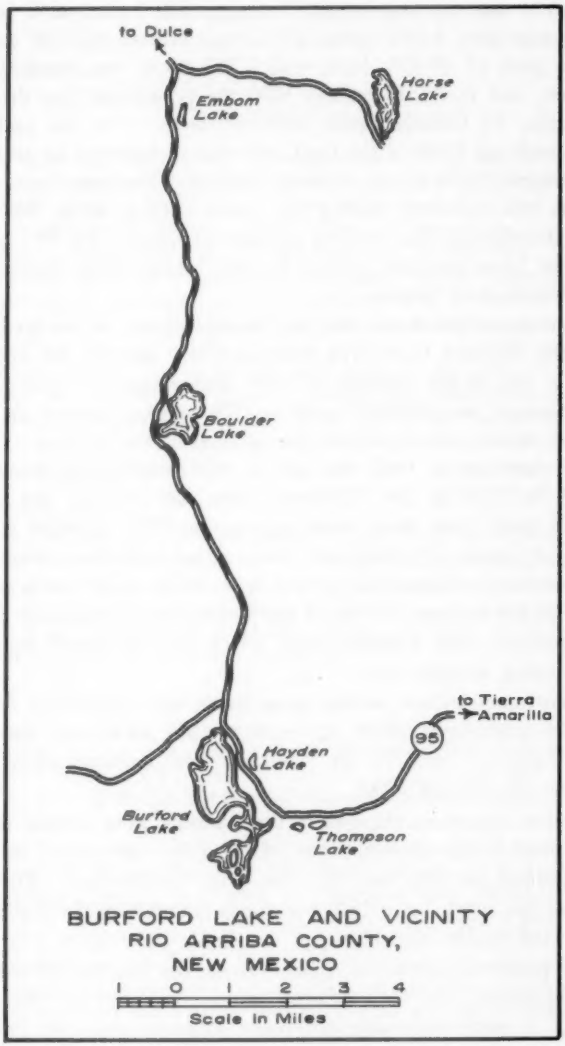
Fish life is still nonexistent in Burford Lake. Rainbow trout have been established by stocking in Horse Lake. This development has had an untoward effect on the value of this lake for waterfowl production. During the breeding season of 1958, approximately 54 broods of ducks were produced on Horse Lake. In 1959, after the stocking of trout, only nine broods were observed; and in 1960, a check revealed only one brood (on 8 June). Even this one brood may not have been raised to flying age on the lake; it could not be located on subsequent counts. These notes are not meant to indicate that trout and ducks are incompatible, but that the presence of fishermen is a source of never-ending disturbance to nesting waterfowl.

Burford Lake is still the host of thousands upon thousands of axolotl (*Ambystoma* sp.), commonly called waterdog, mud puppy, or guajalote. The condition mentioned by Dr. Wetmore during June of 1918 when "they began to die in considerable numbers" was perhaps due to low oxygen levels caused by the decay of submerged aquatic vegetation, or to an excessive level of carbon dioxide given off by this growth on cloudy days when the process of photosynthesis is disrupted. This is not an uncommon cause of fish mortality in shallow, heavily vegetated lakes of New Mexico.

General Discussion

The Burford Lake area attracts many male ducks during the molting period now, as it did at the time of Dr. Wetmore's survey. It seems, however, that there has been a shift in the species involved. Not mentioned in his work, the Pintail is the dominant species. During the summer of 1959, 324 Pintails were banded on Burford, Hayden, and Horse lakes. Of these, approximately 90 per cent were adult males, and the number banded represented less than half of the total population. Total numbers of ducks and coots on Burford Lake during the molting period have approached 5,000 for the past three years.

As mentioned by Dr. Wetmore, this area plays an important role during periods of migration. The spring migration was over by the time of our arrival on 6 June 1960, and, unfortunately, no data are available regarding the numbers of land birds using the area during migration at this time. Dr. Wetmore reported a number of migrant species in May and early June that we did not see. Aerial counts of waterfowl, however, were made biweekly during the fall migration in 1959 and 1960. In 1959 the peak population of ducks, 26,474, and


to Dulce
Horse Lake
Embom Lake
Boulder Lake
to Tierra Amarilla
95
Hayden Lake
Burford Lake
Thompson Lake
BURFORD LAKE AND VICINITY
RIO ARRIBA COUNTY,
NEW MEXICO
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Scale in Miles

coots, 8,275, was reached in mid-October. The count on 8 December 1959 revealed only 1,050 ducks, 29 Canada Geese, and 125 coots. In 1960 the peak of 35,428 ducks and 9,785 coots was reached in late September, and by 11 December 1960 the population had dropped to 1,297 ducks, 14 Canada Geese, and 555 coots. On the peak count, Pintails made up 7,430 of the total, followed in numbers by teal, chiefly Green-winged (6,374), and Mallards (4,610). The peak count of 3,050 Redheads also occurred during this same period, while the peak of 3,375 Canvasbacks was reached in late October. As Dr. Wetmore stated, the lakes become covered by ice during early December and remain frozen until March.

The annotated list shows that the general nature of the bird population in the Burford Lake area was much the same in the summer of 1960 as it was in the summer of 1918, with regard to species present. The annotated list contains notes on 126 species present at Burford Lake and vicinity during either one or both of the surveys. Of these, 21 were recorded in 1960 but not in 1918, and 26 of those species recorded in 1918 by Dr. Wetmore were not seen by our party in 1960. In most cases these were migrants in 1918, summer wanderers in 1960, or species of which only one or two individuals were seen.

The reduction of shoreline growth from 1918 conditions is strikingly reflected in the absence in 1960 of the Yellowthroat, Savannah Sparrow, Song Sparrow, and Virginia Rail, which Dr. Wetmore reported as fairly common nesting birds.

The bird populations of the open fields and sagebrush flats were essentially unchanged after 42 years. One additional species, the Horned Lark, not seen by Dr. Wetmore, was common along the dirt roads near the lake in 1960.

The other important changes in the avifauna were several additional species found in the forested areas. One of the commonest birds in the pinyon-juniper in 1960 was the Blue-gray Gnatcatcher. This species as well as the Scrub Jay, which was fairly common in this habitat, were not reported by Dr. Wetmore.

In the ponderosa pines on Apache Mesa, the Hermit Thrush, Olive-sided Flycatcher, and Gray-headed Junco were seen in 1960 but not in 1918. A more noticeable difference, however, was the presence of large flocks of Red Cross-bills, which were seen in all of the ponderosa pine areas. Also, Clark's Nutcrackers were fairly common in the pines. Neither of these species was reported by Dr. Wetmore. The Williamson's Sapsucker, which was reported as fairly common in this habitat by Dr. Wetmore, was not seen in 1960.

As was mentioned previously, the Pintail, now common in migration as well as during the breeding and molting period, was not recorded by Dr. Wetmore.

ANNOTATED LIST

Podiceps caspicus. Eared Grebe. Although no mention is made of total numbers, Dr. Wetmore states "the Eared Grebe was the most abundant of the breeding marsh birds at Burford Lake." During our survey in June 1960 there were 242 of these birds on Burford Lake, nine on Horse Lake, and four on Hayden Lake. Nesting activities had not yet begun at that time. When we returned in July for waterfowl banding, it was noted that two substantial nesting colonies were under construction in the southern portion of Burford Lake. In some of the nests one egg had already been laid, but no nests were found containing more than one egg. During banding activities in July 1959 two colonies containing approximately 100 nests each were found in the northern portion of Burford near the west shore. These two colonies were about 300 meters apart. Incubation was well advanced in most cases, and some broods had already hatched.

Aechmophorus occidentalis. Western Grebe. There is no mention made of the presence of this bird during Dr. Wetmore's survey, and none were seen during the June period of 1960. In July, however, one was seen on the north portion of Burford Lake.

Podilymbus podiceps. Pied-billed Grebe. These birds were found only on Burford and Hayden lakes during the 1960 survey. There were 30 on Burford and six on Hayden Lake during this period. One nest was found on Hayden Lake in June 1960, and one brood and two nests containing eggs were observed on Hayden Lake in July. The Pied-billed Grebe was listed by Dr. Wetmore "common at Lake Burford, and was breeding."

Pelecanus erythrorhynchos. White Pelican. Dr. Wetmore reported "a few were found in migration" in 1918. None were observed during our 1960 survey.

Ardea herodias. Great Blue Heron. Two summer wanderers were seen in July 1960, but none were seen in June. Dr. Wetmore reported several spring migrants.

Leucophoyx thula. Snowy Egret. Dr. Wetmore reported these in migration. We saw one on 19 July but none in June.

Nycticorax nycticorax. Black-crowned Night Heron. There were 15 pairs of these herons at Burford during Dr. Wetmore's survey. He states that these were preparing to nest in the rushes on Thompson Lake at the time of his departure. During June of the 1960 survey eight Black-crowned Night Herons were found on Hayden Lake and none were observed at any other location. It was common to see all eight of these perched on the posts of a fence, which crossed the south end of the lake. At least half were in subadult plumage. One nest of these birds was found in the bulrushes on the east side of Hayden Lake. In July several adult Black-crowned Night Herons were seen along the shore at Burford Lake.

Botaurus lentiginosus. American Bittern. Dr. Wetmore heard a bittern 29 May and found one 11 June. We found none.

Anas platyrhynchos. Mallard. Dr. Wetmore states that the Mallard was one of the most common species of ducks breeding at Lake Burford. He estimated that 40 pairs were preparing to nest there during the season of 1918. This condi-

tion of relative abundance still exists. It was estimated that 365 Mallards were present on the six lakes included in this survey during the week of 6 June 1960. During a comparable period of 1959, the Mallard population of the area was estimated at 627. An adult male duck, which was quite obviously a Mallard X Pintail hybrid, was taken at Burford Lake during banding activities in the summer of 1960. This bird had just begun the postnuptial molt and still retained the green feathering of the Mallard on the head, but with the white stripe up the side of the neck as on the Pintail. In all sections this bird appeared more or less randomly endowed with the characteristics of either one parent or the other.

Broods Observed

	1960	*1959*	*1958*
Burford Lake	6		1
Hayden Lake	1		
Thompson Lake			2
Stone Lake	1		3
Embom Lake	1	2	2
Horse Lake		2*	8**

* Nine unidentified broods were observed during banding operations 27 July 1959.

** Twenty-eight unidentified broods were observed on Horse Lake on 9 July 1958. No doubt some of these were Mallard broods. Twenty-eight local Mallards were banded at Horse Lake on 22 July 1958.

Anas diazi novimexicana. New Mexican Duck. Dr. Wetmore mentions that on 25 May he observed in the company of a pair of Mallards a "large, very dark-colored duck," which he judged to be a Mexican Duck *(Anas diazi).* He further states that no other ducks of this type were observed. During banding at Hayden Lake on 18 July 1960 an exceptionally dark adult female duck was taken that resembled more nearly a female New Mexican than a Mallard. The bill in particular was distinguishing. Rather than being orange and black, as on the Mallard, it was dark olive-green with small black spots on either side near the base. In connection with a project to attempt the restoration of New Mexican Ducks through artificial propagation, a small number of New Mexican Ducks have been live-trapped by personnel of the New Mexico Department of Game and Fish. The bills of three females being held under this project are olive-green, but are not spotted. For these reasons this bird was considered to be a hybrid New Mexican X Mallard, rather than a purebred.

Anas strepera. Gadwall. It was estimated that 60 pairs of Gadwall were breeding at Burford Lake during Dr. Wetmore's survey. The Gadwall is still common in the area, and during our survey there were 261 Gadwalls present. These birds were mostly paired, but only one Gadwall brood was observed, and this was during banding operations in July 1960. Two Gadwall broods were observed in 1958, one on Thompson Lake and one on Stone Lake. In 1959 one brood was noted on Burford Lake.

Anas acuta. Pintail. No mention is made by Dr. Wetmore of the presence of Pintails in the area. During the past three seasons the Pintail has been an important species here. During the second week of June 1960, 65 Pintails, mostly paired, were present on the six lakes covered. In 1959 there were 375 pairs of Pintails on Burford Lake during the second week of June. There were also 24

pairs of Pintails on Horse Lake, five pairs on Stone Lake, and 29 pairs on Thompson Lake during this same period.

Broods Observed

	1960	*1959*	*1958*
Burford Lake	1		1
Hayden Lake			3
Stone Lake		1	4
Embom Lake			2
Horse Lake	1	1	13*

* Twenty-eight unidentified broods were observed on Horse Lake on 9 July 1958. Seventeen local Pintails were banded on Horse Lake and three on Hayden Lake on 22 July 1958.

Anas carolinensis. Green-winged Teal. The Green-winged Teal is common in the Burford Lake area. Approximately 180 were present in June 1960. In 1918 Dr. Wetmore saw five pairs, which he judged to be nesting at Burford Lake. Molting Green-wings are also common; 40 to 50 have been banded each summer since 1957.

Broods Observed

	1960	*1959*	*1958*
Burford Lake	2	1+*	1*
Hayden Lake			1
Embom Lake			1+*
Horse Lake		2	1+*

* Broods seen and identified only as teal broods. In all cases local Green-winged Teal were banded at these locations. In July 1958, 52 local Green-wings were banded at Horse Lake. In July 1959, 21 local Green-wings were banded on Horse Lake, and three on Burford Lake.

Anas discors. Blue-winged Teal. Dr. Wetmore estimated that four pairs of Blue-winged Teal were nesting on Burford Lake in 1918. During the 1960 survey only two pairs of Blue-wings were seen, but brood count records indicate that Blue-wings are more important than these numbers imply.

Broods Observed

	1960	*1959*	*1958*
Burford Lake	2		
Hayden Lake		2	1
Thompson Lake			6
Embom Lake	1		3
Horse Lake		1	

Anas cyanoptera. Cinnamon Teal. Dr. Wetmore described this species as common. It was estimated during our survey that 57 Cinnamons were present on the six lakes. Due to the difficulty of distinguishing between female Cinnamons

and Blue-wings at any distance, there is only one recorded instance of Cinnamon Teal production in the area. This brood, recorded in 1958, was trapped with the female on Hayden Lake. The female was judged to be a Cinnamon on the basis of bill size and body color. In addition to this, one pair of Cinnamons had been observed on the lake at regular intervals during the breeding season, and no pairs of Blue-wings had frequented Hayden Lake during this period.

Mareca americana. American Widgeon. Dr. Wetmore records two pairs of widgeon apparently nesting at Burford Lake, and single males seen occasionally. During June of 1960 only three widgeon were seen. During banding operations in July 1960 one brood of widgeon was seen on Burford Lake and one on Hayden Lake. These are the only broods of widgeons identified on the area during the past three seasons. Although they are not abundant, male widgeons are not uncommon during the molting period on Burford Lake.

Spatula clypeata. Shoveler. The Shoveler was listed as common at Burford Lake by Dr. Wetmore, and he estimated that 15 pairs nested there in 1918. During our visit in 1960 only seven Shovelers were observed, and brood counts over the previous two seasons noted only one brood in 1959 on Hayden Lake. From this brood two individuals were trapped and banded in July 1959.

Aix sponsa. Wood Duck. Dr. Wetmore did not record the presence of Wood Ducks during his survey, and due to the habitat type this is to be expected. On 18 July 1960, however, as preparations were being made to begin trapping on Hayden Lake, a duck was observed sitting on a post in the north end of the lake. Even at a distance it appeared to be a female Wood Duck, and after approaching unseen to a distance of about 25 meters we made positive identification with the aid of 7 x 50 binoculars.

Aythya americana. Redhead. Dr. Wetmore reported the Redhead as a common breeding bird: "30 pairs were located that seemed settled for the summer." Dr. Wetmore reports locating a Redhead nest containing eight eggs on 4 June 1918. This clutch had increased to 14 by 13 June and was being incubated by the female. During the past few years the Redhead has been common at Burford. Within the survey period of 1960, 111 were observed on the six lakes. Although a few adult males have been banded during the molting period, no broods have been observed, and due to the unique brightness of young Redheads it seems safe to say that no Redhead production has occurred during the past three seasons.

Aythya collaris. Ring-necked Duck. Dr. Wetmore does not mention the Ring-neck in connection with his survey, and no Ring-necks were identified during the 1960 survey. During banding in July 1958, however, three adult male Ring-necks were trapped and banded, and in 1960 another adult male Ring-neck was taken and banded.

Aythya valisineria. Canvasback. Dr. Wetmore reports three pairs of Canvasbacks apparently nesting during his survey. Although he did not locate a nest, he does report having seen two females on different occasions that gave indications of being nesting birds. The Canvasback is now rare in the Burford area except during migration. Only two males were seen during the 1960 survey, and these were single birds on different lakes. No Canvasback production has been observed during the past three seasons.

Aythya affinis. Lesser Scaup. The Lesser Scaup was present at Burford Lake in 1918 but apparently not nesting according to Dr. Wetmore's survey. He reported 10 or 12 pairs present on Burford at that time, and 25 males and 23 females on Hayden Lake on 1 June 1918, but these "moved on at once and were

not seen again." At the time of our survey only nine scaup were seen on all six lakes, and no scaup production has been recorded during the past three seasons.

Bucephala albeola. Bufflehead. Only two male Buffleheads were observed during the 1960 survey; one on Stone Lake and one on Burford Lake. Dr. Wetmore does not mention the presence of these birds during his visit.

Oxyura jamaicensis. Ruddy Duck. The Ruddy Duck, according to Dr. Wetmore, was one of the commonest species on Burford Lake. He estimated that 55 pairs were breeding at the lake during his survey. The Ruddy is still one of the common species in the area; 121 were seen on Burford Lake, and the total for the six lakes covered was 169. Production by the Ruddy is probably limited by the amount of nesting cover available. There was a great deal of interspecific strife between coots and the Ruddy on Hayden Lake where nesting conditions were ideal for overwater nesters. Even though the Ruddy is a pugnacious little individual, he was evidently no match for the coot. As was mentioned earlier there were 43 coots' nests on Hayden, and no Ruddies had nested as of 22 July 1960. No Ruddy broods were observed during 1960; in 1959 one brood was seen on Hayden Lake, and in 1958 two broods were found on Stone Lake.

Mergus merganser. Common Merganser. Dr. Wetmore states that this species is found at Burford Lake during migration. He says "a small flock was seen on May 27 and 14 pairs were observed on May 30." No mention is made of nesting. Only 12 American Mergansers were seen during the 1960 survey. During banding operations in 1959 three adult females were banded, and in 1960 another adult female was banded.

Cathartes aura. Turkey Vulture. Although Dr. Wetmore reported vultures as fairly common, we saw only three at widely scattered locations (7, 11, and 12 June).

Accipiter striatus. Sharp-shinned Hawk. None observed in 1960. Dr. Wetmore reports them as nesting in small numbers.

Accipiter cooperii. Cooper's Hawk. One was seen twice (8, 12 June) near southeast shore of Burford Lake, both times harried by Brewer's Blackbirds. Dr. Wetmore saw one on the hillside east of Burford Lake.

Buteo jamaicensis. Red-tailed Hawk. One or two pairs nested in the rocky hills bordering the canyon below the lake in 1918. None were seen during the 1960 survey period.

Aquila chrysaëtos. Golden Eagle. At least three (one adult, two immatures) were present in June 1960. A possible nesting pair was observed by Dr. Wetmore.

Circus cyaneus. Marsh Hawk. Several individuals were seen by Dr. Wetmore. Apparently this species did not nest. We saw none in 1960.

Falco mexicanus. Prairie Falcon. Dr. Wetmore reported one pair that nested on an inaccessible ledge in the canyon below the lake. None were seen by us.

Falco peregrinus. Peregrine Falcon. A successful nesting of a pair of Peregrine Falcons (duck hawks) was reported by Dr. Wetmore in the canyon south of Burford Lake. We saw one adult sitting on the Burford shoreline 7 June, and single birds were seen in flight on two other occasions.

Falco sparverius. Sparrow Hawk. Although one or two of these were seen daily by Dr. Wetmore, we saw them only occasionally; probably four individuals.

Meleagris gallopavo. Turkey. Dr. Wetmore reported seeing signs of Turkey east of the lake. We saw no evidence of Turkeys.

Rallus limicola. Virginia Rail. Dr. Wetmore reported hearing these rails on

five different occasions and suggested that possibly a pair nested. None were seen or heard by our party.

Fulica americana. American Coot. Dr. Wetmore states that "Next to the Eared Grebe and Yellow-headed Blackbird, the coot was the most abundant breeding species" at Burford Lake. He estimated that 150 pairs were nesting at the lake. The coot's relative importance remains about the same in the area, but the center of activity is on Hayden Lake, rather than Burford. As was stated previously, 43 coots' nests containing eggs or young were found on Hayden Lake. Coot nesting activities on Burford Lake, where 1,439 coots were counted, were just beginning at the time of the 1960 survey. It is estimated that there were not over 20 nests on Burford during the June survey. During banding activities in July there were probably as many nests, and numerous young were seen. The total count of coots on the six lakes surveyed in June 1960 was 1,659.

Charadrius vociferus. Killdeer. As during Dr. Wetmore's visit, a pair was seen, probably nesting, in June on the east shore of Burford Lake. Eight were seen along the shores of Lake Burford on 9 June.

Actitis macularia. Spotted Sandpiper. Dr. Wetmore observed 25 on 25 May, then single birds through 5 June. We saw none 6-12 June, but two were seen 19 July.

Catoptrophorus semipalmatus. Willet. One was seen by Dr. Wetmore on 27 May. We saw none.

Limnodromus scolopaceus. Long-billed Dowitcher. Two were seen feeding on a sandbar near the south end of Lake Burford on 19 July. These birds were not reported by Dr. Wetmore.

Recurvirostra americana. American Avocet. One avocet nest, a shallow depression lined with dead weeds, containing four olive-drab eggs heavily spotted with dark brown, was found 9 June. Eleven avocets were counted around the shoreline of Lake Burford. Dr. Wetmore did not report the presence of this species.

Himantopus mexicanus. Black-necked Stilt. Four were reported by Dr. Wetmore as present on the north shore of Burford Lake on 30 May 1918. We saw none.

Steganopus tricolor. Wilson's Phalarope. Present during migration, 1918. Two seen 19 July 1960 on Lake Burford.

Larus delawarensis. Ring-billed Gull. Immatures were present during Dr. Wetmore's entire stay. We saw 11, of which two were immatures, at the north end of Lake Burford, and 11 on Stone Lake on 7 June. They were also present in July.

Larus pipixcan. Franklin's Gull. This gull was "fairly common during migration" according to Dr. Wetmore. Flocks of 20 and 30 were seen on 13 and 14 June, respectively. We saw none.

Chlidonias niger. Black Tern. Dr. Wetmore saw three on 6 June at Lake Burford; we saw five on Stone Lake 7 June. Four were present on Lake Burford in July.

Zenaidura macroura. Mourning Dove. Although common in all habitats around Lake Burford, doves were never seen in the abundance reported by Dr. Wetmore, who sometimes saw two or three hundred in the canyon below the lake. Doves watered regularly at the pond near headquarters. Fourteen (3 males, 1 female, 10 immatures) were banded here, and one female was banded at banding site No. 4.

Bubo virginianus. Great Horned Owl. This owl was fairly common in the gulches above Burford Lake during Dr. Wetmore's visit. None were recorded by us.

Chordeiles minor. Common Nighthawk. Dr. Wetmore reported the arrival of the first nighthawk on 2 June. Nighthawks were abundant when we arrived on 7 June. Shortly after dark each evening they could be found resting on the dirt roads north of Burford Lake. Twenty were seen in four-fifth kilometer (one-half mile) on the north side of the lake on the evening of 7 June. Two were caught in dip nets from a jeep. Two more were caught in nets at the headquarters pond (site No. 1) in July.

Aëronautes saxatalis. White-throated Swift. Dr. Wetmore found swifts fairly common about the ledges of the high cliffs in the canyons near Lake Burford. This was also true during our survey; the greatest number seen was seven, above the east shore of Burford Lake.

Selasphorus platycercus. Broad-tailed Hummingbird. Seen daily by Dr. Wetmore in pinyons and pines. We recorded a few in the same habitat, but they were commonest along the edge of stream beds west of the lake; 12 were seen on 12 June.

Colaptes cafer. Red-shafted Flicker. Dr. Wetmore reported flickers spent much time feeding on the ground in the sagebrush. We did not see this, but found them scattered in the ponderosa pine and pinyon areas. Three were caught and banded at the headquarters pond.

Asyndesmus lewis. Lewis' Woodpecker. One seen on a ponderosa south of Horse Lake 12 June. None were recorded by Dr. Wetmore.

Sphyrapicus thyroideus. Williamson's Sapsucker. Dr. Wetmore reported this species to be fairly common among the ponderosa pines on the hills above Burford Lake. We saw none.

Dendrocopos villosus. Hairy Woodpecker. Reported as fairly common in the forested hills by Dr. Wetmore. We found this also to be the case. A family of four were seen 11 June along the stream bed west of the lake. One was banded at site No. 4 in June.

Tyrannus vociferans. Cassin's Kingbird. Dr. Wetmore reports these kingbirds as fairly common after 25 May, and nesting in scattered ponderosa pines on rocky hillsides. We saw only two in fields south of headquarters on 12 June.

Myiarchus cinerascens. Ash-throated Flycatcher. Dr. Wetmore saw only one, and so did we, on the oak-pinyon-covered slope near his cabin site.

Sayornis saya. Say's Phoebe. Fairly common on open flats during Dr. Wetmore's and our visits. One nest in a barrel in a shed attached to the headquarters building contained two young and one unhatched egg on 8 June 1960. Another nest was located under a bridge on the road near headquarters. One was banded in June and one in July at the headquarters pond (site No. 1).

Empidonax oberholseri. Dusky Flycatcher. Reported by Dr. Wetmore as common among junipers and pines at Lake Burford. We heard and saw them in June on the pine-covered mesas (assumed to be Dusky and not Hammond's, because of the habitat).

Contopus sordidulus. Western Wood Pewee. As reported by Dr. Wetmore, this pewee was common in hills above Lake Burford. On 7 June we saw at least 15. Five were banded at the headquarters pond (site No. 1), and one at site No. 4.

Nuttallornis borealis. Olive-sided Flycatcher. Two were heard and seen in

the ponderosa pines on Apache Mesa, northeast of Lake Burford on 7, 10, 11, and 12 June 1960. Not reported by Dr. Wetmore.

Eremophila alpestris. Horned Lark. These birds were flushed regularly from roads around Lake Burford (at least 12) in June 1960. They were still present in July. Dr. Wetmore reported none.

Tachycineta thalassina. Violet-green Swallow. Dr. Wetmore recorded flocks of these swallows about his cabin during May. By 2 June "they had retired to the hills." After 7 June few came down along the lakeshore. Violet-green Swallows were present in large numbers in the Burford Lake area 6 to 11 June 1960. They would appear at Hayden Lake just before a rainstorm and feed low over the water, apparently catching insects at or near the surface. Several thousand were seen at Hayden Lake 6 June. Other small flocks were seen near the headquarters pond. In June, 26 were banded at the pond (site No. 1), 115 at Hayden Lake (site No. 2), and in July, three more were banded at site No. 1.

Iridoprocne bicolor. Tree Swallow. One adult Tree Swallow was carefully identified in the large flock of Violet-green Swallows on 6 June 1960. Two more were seen at Horse Lake 8 June 1960. Dr. Wetmore reported none.

Stelgidopteryx ruficollis. Rough-winged Swallow. Dr. Wetmore saw individuals on 24 and 25 May and a pair on 8 June near his cabin. We saw at least 20 in the large swallow flock on 6 June. Seven were banded at Hayden Lake (site No. 2) on 6 June, and one was banded at the headquarters pond (site No. 1).

Hirundo rustica. Barn Swallow. Dr. Wetmore reported one near his cabin on 10 June and a pair on 14 June. We saw only two on 6 June at Hayden Lake.

Petrochelidon pyrrhonota. Cliff Swallow. One Cliff Swallow was seen 25 May 1918 by Dr. Wetmore, and he goes on to report that on 26 May a flock of 25 appeared and that they were common from then on. They began building nests on the sandstone cliff above the Laguna de la Puerta on 9 June. We saw old nests on cliffs near the east side of Burford Lake, but there was no evidence of recent nesting. A few were seen at Hayden Lake on 6 and 7 June, and seven were banded.

Progne subis. Purple Martin. Migrant birds were observed by Dr. Wetmore above Burford Lake on 8, 13, and 19 June. No martins were observed during the 1960 survey period.

Perisoreus canadensis. Gray Jay. "One was seen on a high hill east of the lake on June 16" by Dr. Wetmore. We saw none.

Cyanocitta stelleri. Steller's Jay. This jay was common among the yellow pines above Burford Lake in 1918. We found it common also, especially west of the lake.

Aphelocoma coerulescens. Scrub Jay. Although Dr. Wetmore saw no Scrub Jays, we found them fairly common on the pinyon-juniper hillsides about the lake.

Pica pica. Black-billed Magpie. Dr. Wetmore reported that one or two pairs nested near the eastern shore of Burford Lake in 1918. Two were seen east of Thompson Lake on 6 and 7 June in 1960.

Corvus corax. Common Raven. Ravens were common around Burford Lake in 1918. They nested on cliffs in the canyon below the lake and fed daily along the shore. They were seen only occasionally during our survey. Two were seen soaring over the bluffs east of Burford Lake on 6 June.

Corvus brachyrhynchos. Common Crow. Dr. Wetmore reported that several

pairs nested about the lake and came daily to the shore. We saw none at Burford Lake, but three were seen at Thompson Lake on 8 June.

Gymnorhinus cyanocephala. Piñon Jay. The Piñon Jay was reported as common among the pines and junipers on the hills about the lake by Dr. Wetmore. A flock of 100 fed among the sage-covered knolls 14 and 17 June 1918. We found them common around the lake in June and July. A flock of 85 was seen in the ponderosa pines near the headquarters cabin.

Nucifraga columbiana. Clark's Nutcracker. Dr. Wetmore reported no nutcrackers. We saw them regularly in the pines on the hills about the lake in June. Six were near the cabin 19 and 21 July. Two were netted and banded at the headquarters pond (site No. 1).

Parus gambeli. Mountain Chickadee. Chickadees were reported by Dr. Wetmore as fairly common in the ponderosa pines about Burford Lake. We noted four on Apache Mesa on 8 June. Two were banded at the spring (site No. 4).

Sitta carolinensis. White-breasted Nuthatch. This nuthatch was fairly common in the pines above the lake in 1918. We found it restricted to the ponderosa on the mesa tops. Three were observed on 12 June.

Sitta pygmaea. Pigmy Nuthatch. Reported as breeding and fairly common in the ponderosa pines by Dr. Wetmore. They were well distributed throughout the pines during our visit. Twenty were recorded on one mesa on 12 June 1960.

Troglodytes aedon. House Wren. Fairly common in the wooded areas on the hills above the lake during Dr. Wetmore's visit. We saw a few in brushy areas.

Telmatodytes palustris. Long-billed Marsh Wren. Only one was reported by Dr. Wetmore, and none were recorded in 1960.

Catherpes mexicanus. Cañon Wren. Dr. Wetmore discovered and investigated a nest on a ledge in a canyon east of the lake. It was empty 9 June. On 16 June it contained four eggs. We heard only one bird singing in a canyon in the same area on 12 June.

Salpinctes obsoletus. Rock Wren. As reported by Dr. Wetmore, we found Rock Wrens common in the rocky areas about the lake. It is the typical bird of the broken rock edges. A family of four were seen on 9 June.

Mimus polyglottos. Mockingbird. Dr. Wetmore reported mockingbirds fairly common in the junipers and in the canyons near the lake. We saw a few regularly in the sagebrush at the north end of Burford Lake.

Oreoscoptes montanus. Sage Thrasher. This species was fairly common after 29 May in sagebrush about the lake during Dr. Wetmore's visit. Singing thrashers were scattered in the areas covered by sagebrush during our visit in June. We banded one, caught in the sagebrush (site No. 3) on 10 June 1960.

Turdus migratorius. Robin. Dr. Wetmore reported that "the Western Robin nested commonly in the gulches around Burford Lake, and one or two pairs were found in the grove of cottonwoods near the spring." We found a nest with young in a juniper near the spring. Several were seen daily near our cabin. Eleven robins, seven at the headquarters pond (site No. 1), two at Hayden (site No. 2), and two at the spring (site No. 4) were banded, including the female of the above-mentioned nest. She was caught at Hayden Lake, four-fifths kilometer (one-half mile) away on 8 June, then renetted at the spring, 9 and 10 June.

Hylocichla guttata. Hermit Thrush. Although Dr. Wetmore reports none, we heard two singing in the ponderosa on top of Apache Mesa on 8 and 12 June.

Sialia mexicana. Western Bluebird. A few of these bluebirds were observed

at frequent intervals by Dr. Wetmore. Only three pairs were seen near our cabin, but nine were caught and banded at the pond (site No. 1) in June, and four more (immatures) were banded at this location in July.

Sialia currucoides. Mountain Bluebird. Dr. Wetmore reported the Mountain Bluebird as common, ranging from the lakeshore to the tops of the hills. We observed them mainly about the cabin area and in the streamside area south of our cabin. A pair nested in the wall of the pumphouse at the cabin. The female was feeding young and dodged the nets beside the pond (site No. 1) some three meters away. Two adults were banded here in June, and five immatures in July.

Myadestes townsendi. Townsend's Solitaire. Dr. Wetmore did not record this species. We saw four in the ponderosa pine on Apache Mesa on 12 June.

Polioptila caerulea. Blue-gray Gnatcatcher. This bird, not recorded by Dr. Wetmore, was common in the pinyon-juniper on the low hills around the lake. Four were seen in the area near Dr. Wetmore's cabin site on 7 June.

Sturnus vulgaris. Starling. No starlings were present at Burford Lake in 1918. We saw two on 7 June and two on 11 June, but noticed no nesting activity.

Vireo solitarius. Solitary Vireo. Dr. Wetmore reported this vireo as common in the ponderosa pine in the hills above the lake from 26 May to the end of his stay. None were around our cabin area in June, but they were scattered in the pine on top of Apache Mesa, 12 June. Four were noted near the headquarters cabin on 20 July.

Vireo gilvus. Warbling Vireo. First seen by Dr. Wetmore, 2 June. They were found in thickets lining the gulches and among the aspens. We recorded no warbling Vireos.

Vermivora celata. Orange-crowned Warbler. These warblers nested in small numbers in gulches below the lake in 1918. We observed no Orange-crowned Warblers during our survey.

Vermivora virginiae. Virginia's Warbler. As during Dr. Wetmore's visit, Virginia's Warblers were common among the thickets of small oaks in the gulches and on the higher slopes around the lake. One was banded at site No. 4 on 9 June.

Dendroica petechia. Yellow Warbler. This warbler was found by Dr. Wetmore only as a migrant; single birds were seen on 23 May and 1 June 1918. We banded one at the headquarters pond, 7 June 1960 (site No. 1). No others were seen.

Dendroica auduboni. Audubon's Warbler. Fair numbers nested in the ponderosa pine areas about the lake in 1918. We found them common in these areas in 1960. Three were banded at the headquarters pond (site No. 1).

Dendroica graciae. Grace's Warbler. Dr. Wetmore found a few at the head of one of the gulches east of the lake on two occasions, 9 and 16 June. We found them scattered in the ponderosa pine areas, generally foraging near the tops of trees.

Seiurus noveboracensis. Northern Waterthrush. Dr. Wetmore reported, "one was observed at the spring on May 23 and 25." None were seen during our survey in 1960.

Geothlypis trichas. Yellowthroat. Dr. Wetmore estimated 15 pairs were breeding in the tules in water next to the shore of Burford Lake in 1918. None were seen or heard during June and July 1960.

Wilsonia pusilla. Wilson's Warbler. Dr. Wetmore saw a few of these warblers during migration. We saw none.

Sturnella neglecta. Western Meadowlark. Dr. Wetmore reported, "Meadowlarks were fairly common in open localities about the shores of the lake," in 1918. We found them fairly common throughout the sagebrush areas.

Xanthocephalus xanthocephalus. Yellow-headed Blackbird. Dr. Wetmore found this blackbird to be the most abundant breeding bird, next to the Eared Grebe. He estimated 210 pairs were nesting. We estimated that there were 100 nests at Hayden Lake in June 1960. Another colony was found nesting at Embom Lake, but none were nesting at Burford Lake. Young were out of the nest in July, clambering about the bulrush. We caught six young in a dip net from a boat and banded them at Hayden Lake, 20 July. Nine adults and subadults, three males and six females, were trapped and banded at Hayden Lake (site No. 2) in June. These blackbirds fed among the sagebrush around Burford Lake. One male was caught in a net in the sagebrush (site No. 3) on 11 June 1960.

Agelaius phoeniceus. Red-winged Blackbird. "The redwing was abundant at Lake Burford and it was estimated that 20 pairs were nesting here, scattered along the shore of the lake among the abundant yellowheads," according to Dr. Wetmore. A few were present only on Hayden Lake in 1960. Three (two males and one female) were caught in nets and banded at Hayden Lake (site No. 2).

Euphagus cyanocephalus. Brewer's Blackbird. Dr. Wetmore reported only one pair that nested near a hayfield below Laguna de la Puerta. In 1960 an estimated 20 pairs were present around the Laguna. One female was banded at Hayden Lake (site No. 2) in June 1960.

Molothrus ater. Brown-headed Cowbird. Dr. Wetmore observed one mated pair plus an additional male and female. One sight record, a male at Hayden Lake, was made on 7 June 1960.

Piranga ludoviciana. Western Tanager. Fairly common among the ponderosa pines in 1918 and 1960. One was banded at the spring (site No. 4) in June, and one at the headquarters pond (site No. 1) in July 1960.

Pheucticus melanocephalus. Black-headed Grosbeak. As Dr. Wetmore observed, this grosbeak was rather rare about the lake. He saw males on 2 and 9 June, "in a gulch in the hills." We saw one in the stream bed south of the cabin on 11 June, and two on Apache Mesa on 12 June.

Carpodacus cassinii. Cassin's Finch. Dr. Wetmore saw one male on a high hill east of the lake on 9 June. We saw none.

Carpodacus mexicanus. House Finch. One House Finch was observed by Dr. Wetmore on 16 June 1918. We saw a male and female near the cabin on 6 June.

Spinus pinus. Pine Siskin. Siskins were seen by Dr. Wetmore in the hills above the lake on 26 and 28 May and 16 June. We saw none in 1960.

Loxia curvirostra. Red Crossbill. Dr. Wetmore reported no crossbills. In 1960 they were common in the ponderosa pine areas. A flock of 25 immatures, and adults of both sexes, frequently visited the headquarters pond. Eleven were banded at the pond (site No. 1).

Chlorura chlorura. Green-tailed Towhee. This towhee was reported as "fairly common on the sage-grown slopes above the lake" by Dr. Wetmore. We saw

four individuals in June at scattered locations. An adult seen near the spring (site No. 4) was carrying insects in its beak.

Pipilo erythrophthalmus. Rufous-sided Towhee. This towhee was common in thickets, on the slopes, and in gulches above the lake during Dr. Wetmore's visit. We found them scattered in the same habitat.

Passerculus sandwichensis. Savannah Sparrow. Small numbers were found by Dr. Wetmore in dead growths of three-square near the open shores on the northern and southern sides of Burford Lake from 28 May to 6 June 1918. We saw none.

Pooecetes gramineus. Vesper Sparrow. The Vesper Sparrow was common through the sagebrush on the flats and knolls surrounding the lake in 1918. This and the Brewer's Sparrow were the commonest birds of the sagebrush during 1960. Singing birds were heard everywhere. Six were caught and banded in the sagebrush (site No. 3) and five at the headquarters pond (site No. 1).

Chondestes grammacus. Lark Sparrow. Dr. Wetmore reported only one pair that was nesting on an open flat above the grove of large cottonwoods (site No. 4), but that they were common near El Vado, approximately 10 kilometers (six miles) to the east. We found them fairly common on the sagebrush flats. One was banded at the headquarters pond (site No. 1) in June.

Amphispiza belli. Sage Sparrow. Dr. Wetmore reports this sparrow as "locally distributed and breeding in the sage grown areas." We saw three individuals in the sage on 7 June and three on 12 June.

Junco caniceps. Gray-headed Junco. Although none were reported by Dr. Wetmore, we saw a few in the ponderosa pines on Apache Mesa on 12 June 1960.

Spizella passerina. Chipping Sparrow. The Chipping Sparrow was fairly common in junipers near the lakeshore and was found also among the pines covering the hills back from the lake during Dr. Wetmore's stay. We found them common in those areas also. Twelve were counted in our cabin area on 7 June. Thirteen were banded at the pond (site No. 1), and five near the spring (site No. 4) in June.

Spizella breweri. Brewer's Sparrow. This sparrow was reported by Dr. Wetmore as one of the most common breeding birds in the sagebrush areas. We found them very common; singing birds were distributed regularly throughout the sage. Four were banded at the pond (site No. 1), and four in the sagebrush (site No. 3) in June 1960.

Zonotrichia leucophrys. White-crowned Sparrow. "These sparrows appeared in migration in the bushes near the lake on 28 May and remained until 4 June. During this period they were fairly common," reported Dr. Wetmore. We saw none.

Melospiza lincolnii. Lincoln's Sparrow. No Lincoln's Sparrows were reported by Dr. Wetmore. One was caught and banded at the headquarters pond (site No. 1) on 10 June 1960.

Melospiza melodia. Song Sparrow. The Song Sparrow nested near Burford Lake in 1918, and Dr. Wetmore reports young birds common after 4 June. We saw no Song Sparrows in 1960.

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HYBRIDS AMONG THE FRINGILLID GENERA *JUNCO-ZONOTRICHIA* AND *MELOSPIZA*

ROBERT W. DICKERMAN

THE fringillid genera *Junco, Zonotrichia, Passerella,* and *Melospiza* form a closely related group. This relationship is indicated by the lack of distinctive morphological characters, and in part by the abundance of hybrids between *Junco hyemalis* and *Zonotrichia albicollis* (Townsend, 1883; Stone, 1893; Snyder, 1954; Warburton, 1959; and the Hamiltons, 1957). Additional records of hybrids between these two species include an adult male, taken 14 October 1959 at the Kalbfleisch Field Station of the American Museum of Natural History by Wesley E. Lanyon, and a bird (identified by Drs. Alexander Wetmore and John Aldrich) banded and released at Fairfax, Virginia, by Mrs. M. Brantley Peacock on 18 April 1960. Mrs. Brantley kindly furnished a detailed description of the bird she banded, which appears to have been a bird of the year. Further support for the closeness of this relationship is provided by a hybrid between *Zonotrichia leucophrys pugetensis* and *Melospiza melodia morphna* that I collected on 26 June 1959 on the west side of San Juan Island, Washington. The specimen, a juvenile male (University of Minnesota Museum of Natural History 15515), was collected from what appeared to be a family group of young birds. It is in slightly worn, but full juvenile plumage. A juvenile *Zonotrichia leucophrys* was collected the same day. These two specimens were not compared with other juvenile sparrows until I returned to Minneapolis, when the atypical appearance of what I had assumed to be a slightly odd Song Sparrow was realized. The specimen, along with juveniles of the other two species, was sent to Thomas D. Burleigh, who wrote that he considered the specimen to be a well-marked hybrid, and to Alden H. Miller, who wrote "I believe we must acknowledge that it is a hybrid . . . even though there are some unexplained features about it."

The intermediate characters of the hybrid may be clearly seen in the photographs. The hybrid is superficially more similar to the Song Sparrow, being much darker at least above than the White-crowned Sparrow. The most obvious hybrid character is found in the pattern on the head, in which the crown stripe is more pronounced and the superciliary line is fully as light as in *Zonotrichia.* The most striking feature of the hybrid is that the ventral streaking of both parental types is lacking except for a weakly developed mustache mark. The ground tone of the flanks and belly of the hybrid is lighter than the

juvenile *morphna* at hand, but Dr. Miller informs me that some young *morphna* are as light in these regions as is the hybrid. The rectrices are shaped like those of *Melospiza;* however, the second tail feathers are relatively longer, giving the tail a squarer shape as in *Zonotrichia.* The wings are more rounded as in *Melospiza.* The ninth primary is shorter than the third in the hybrid and *Melospiza,*

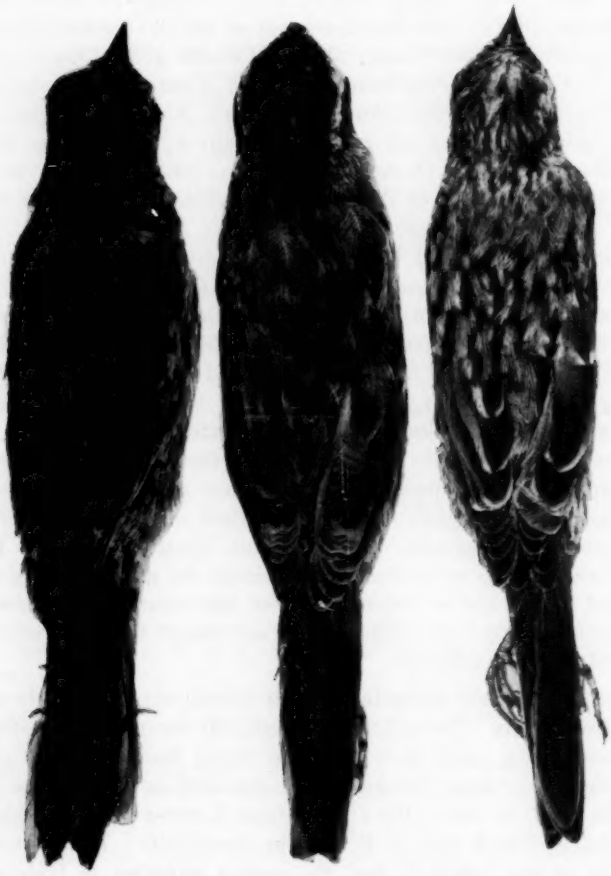

Figure 1. Dorsal view of juvenile sparrows, from left to right: *Melospiza melodia*, hybrid *Melospiza melodia* x *Zonotrichia leucophrys*, and *Zonotrichia leucophrys*.

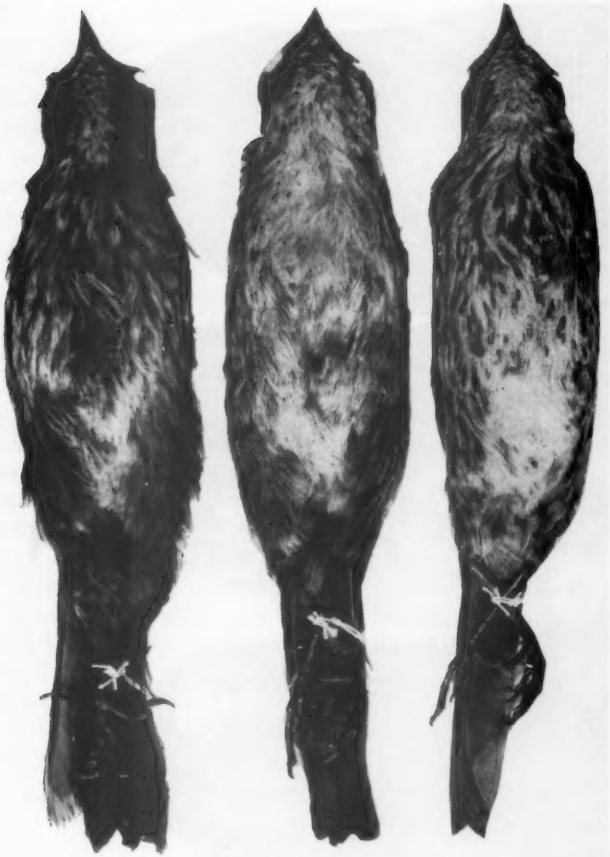

Figure 2. Ventral view of juvenile sparrows, same order as Figure 1.

and it is longer than the third in *Zonotrichia*. The eighth primary is shorter than the fifth in the hybrid and *Melospiza*, and equal to the fifth in *Zonotrichia*. The hybrid measures: wing, 66 mm.; tail, 64 mm.; tarsus, 21.3 mm. The wing and tail measurements fall in the lower portion of these measurements for 13 juvenile male Song Sparrows of the local race that measured 66 to 70 mm. and 62 to 69 mm., respectively. The tarsus of the hybrid is shorter than any of the juveniles of *morphna* (21.8-23.8), and within the range of the six juvenile male *pugetensis* (21.0-22.7). The bill of the hybrid is abnormal, resembling

Figure 3. Portraits of juvenile sparrows, top to bottom same order as in Figure 1.

that of a young crossbill, possibly indicating a type of developmental or hereditary incompatability of this type of cross. It should also be noted that the bill of the *Junco* x *Zonotrichia* hybrid collected at Dalton, Georgia (the Hamiltons, 1957) is also abnormal. However, the bills of the other *Junco* x *Zonotrichia* hybrids are apparently normal.

On San Juan Island the White-crowned Sparrow is a common breeding bird of the brushy field edges. The Song Sparrow is generally slightly less common and more restricted to the more moist habitats in forest openings and along brushy swales and streamsides. The hybrid was collected from brush at the base of a low bluff along a large tidal bay. Open hayfields, bordered by woods, lie above the bluffs, providing suitable habitat for both species.

The relative frequency with which hybrids within the *Junco-Zonotrichia-Melospiza* group are being found indicates a close relationship among these genera not indicated by their arrangement in the A.O.U. *Check-list* (Fifth Edition, 1957). In the *Check-list*, the genus *Spizella* separates *Junco* from the latter two genera, and *Passerella*, obviously close to if not congeneric with *Melospiza*, but farther from the core group, is between *Melospiza* and *Zonotrichia*. *Spizella* should be shifted to a place in front of *Aimophila*, to which some authors believe it related. The alternative would be to place it near *Emberiza*, to which others consider it related. However, the structure of the palatomaxillaries (Tordoff, 1954) would seem to make the latter placement less tenable. Hence the following arrangement might better illustrate the generic relationships of this group of New World fringillids.

Spizella
Aimophila
Amphispiza
Junco
Zonotrichia
Melospiza
Passerella

I wish to thank Alden Miller and Thomas Burleigh for examining the hybrid specimen for me and giving their critical comments. Alexander Wetmore and Wesley Lanyon kindly gave me information on additional hybrid specimens that had not been previously recorded.

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GENERAL NOTES

Lipase Activity in the Heart Muscle of a Migratory and a Nonmigratory Bird.—It has been shown that the lipase activity of the cardiac muscle is directly related to the heart rate (George and Iype, 1959). This relationship is to be expected since fat is known to be a major fuel in cardiac metabolism (Visscher, 1938; Bing, 1956) and also because neutral fats can be enzymically hydrolyzed into fatty acids that can then be oxidized by the cardiac muscle. When there is an increase in the heart rate, the energy expended should also be increased and hence there should also be an increase in fat utilization. Under these conditions, an increase in lipase activity also could be expected in order to turn out more fatty acids for the increased demands of the heart. The relationship between heart-muscle lipase activity and the rate of heart beat has been shown in the heart of the developing chick (George and Iype, 1959), in the postnatal development of the rat, and also in the pigeon under experimental conditions that alter the heart rate (George and Iype, unpubl.). In the present study the heart-muscle lipase activity of a migratory and that of a nonmigratory bird have been studied.

The Rosy Pastor *(Pastor roseus)* and the Common Myna *(Acridotheres tristis)* were chosen as types for the migratory and nonmigratory bird, respectively. The birds were collected by trapping them in a mist net. Hearts from freshly decapitated birds were taken, and the ventricular portion was cut out and blotted free of blood. After carefully removing the adipose tissue and blood, the tissue was taken for the enzyme assay. In each case a 2.5 per cent homogenate in distilled water was prepared in a chilled mortar, and the lipolytic activity was determined manometrically in a bicarbonate-carbondioxide buffer system of pH 7.4 at 37°C (adapted from Martin and Peers, 1953). Four per cent (v/v) tributyrin in 0.0148 M $NaHCO_3$ emulsified by shaking with a drop of "Tween 80" was used as the substrate. Lipase activity is expressed as the number of μl CO_2/mg protein/hour. Protein was determined according to the micro-Kjeldahl steam distillation method (Hawk *et al.*, 1954).

The lipase activity of the Rosy Pastor cardiac muscle was found to be 28.02 and that of the myna 36.78 μl CO_2/mg protein/hour (average of five experiments). It is known that smaller birds have a higher heart rate (Sturkie, 1954). The Common Myna and Rosy Pastor are more or less of the same size. So it might be expected that the heart rate as well as the heart-lipase values of these two birds also should be similar. But the results obtained show that the lipase activity in the myna's heart is distinctly greater and that a higher heart rate for this bird is also indicated. There are at present no data available on the heart rate of these species. However, it is a well-known fact that marathon runners have a low pulse rate (Schneider and Karpovich, 1948: 179-182). Similarly one might expect a lower heart rate in migrating birds. So the lower lipase value for the Rosy Pastor heart may be indicative of a lower heart rate in this bird that indulges in prolonged and sustained flight. In this context it may be mentioned that it has been observed that of all the parts and organs of the body of a migratory bird the heart alone shows no increase in fat content just before migration (Odum and Perkinson, 1951).

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Tail Molt of the Saw-whet Owl.—The sequence of tail molt of birds, especially owls, is not well known. Since Mayr and Mayr in their study of the tail molt of small owls (*Auk*, 71: 172-178, 1954) did not examine a molting specimen of either *Aegolius* or *Micrathene*, the following observations of the molt of a captive Saw-whet Owl (*Aegolius acadicus*) seem relevant.

The bird, an adult female, was caught by hand on 12 November 1960 near Ann Arbor, Washtenaw County, Michigan, and was maintained indoors at The University of Michigan Museum of Zoology until late spring 1961. During this time studies of metabolism and molt were conducted. The Saw-whet Owl is recorded as having one full molt in the fall (Bent, U.S. Nat. Mus. Bull., 170: 233, 1938), but my bird began its molt in late February and finished in early May. This unusual timing is probably a result of captivity and long artificial day lengths. The tail was lost in one week about halfway through the period of molt. The bird appeared tailless for about three weeks, after which time the new tail feathers were as long as the unmolted under tail coverts. Examination of the feathers that were lost and the incoming feathers indicated that the tail molt proceeded inward, with the two innermost rectrices being lost last. The rest of the body molt closely followed the sequence outlined for young Screech Owls (*Otus asio*) by Kelso (Biological Leaflet 50, 1950).

This essentially simultaneous molt of the tail in *Aegolius* was predicted by Mayr and Mayr (*loc. cit.*) because tail molt "tends to be simultaneous in all small [owls]." They suggest that simultaneous tail molt may be the result of "relaxation of selection" for gradual tail molt, which "is presumably based on a more complex physiological mechanism." Presumably the disadvantages of loss of maneuverability caused by taillessness are more than offset by the selective advantages of a decrease in the duration of tail molt.—CHARLES T. COLLINS, *The University of Michigan Museum of Zoology, Ann Arbor, Michigan.*

A Curtailed Postjuvenal Molt in the Steller Jay.—A first-year male of the Steller Jay (*Cyanocitta stelleri*) obtained by Ward C. Russell near Santa Cruz, California, on 26 April 1961, is of interest because it shows retention of juvenal feathers to a degree unlike that of first-year birds of the local population and

comparable to that shown by low-latitude races. In additional respects, it is more extreme than southern populations of this and other species of American jays examined to date, with the exception of *Cyanolyca mirabilis* of Guerrero (Pitelka, MS; 1945, *Condor*, 47: 229-261, and 1958, *ibid.*, 60: 38-49).

Normally, first-year Steller Jays of central California retain juvenal remiges, rectrices, alula, all greater primary coverts, and some greater secondary coverts. Additional juvenal feathers present on the specimen reported here are as follows: (1) some of the under tail coverts, including the two longest ones; (2) some of the upper tail coverts, again including the two longest ones; (3) a greater proportion of the greater secondary coverts (only the two innermost ones are new); (4) some middle secondary coverts (normally all are replaced); (5) some nasal bristles (a few retained only occasionally in the local population); (6) a group of feathers at the outer margin of the sternal region of the ventral tract, evident superficially behind the bend of the wing; (7) scattered feathers at the sides of the dorsal (saddle) region of the spinal tract; (8) an occasional feather in the malar region on the head and at the sides of the cervical region ventrally; (9) some distal feathers of the crural tract over the tarsal joint.

In addition, while the specimen is of normal coloration superficially, the body feathers basally are a very light gray and thus lacking the usual amounts of melanin. In slight disarray of body plumage, the subsurface whiteness becomes conspicuous whereas such contrast is lacking in normal specimens. The body plumage ventrally is also distinctly sparser than normal. Feathers of the femoral tract are excessively worn, except distally, so that the muscular portion of the leg is almost naked. Here, also, the plumage may have been sparser, or both sparser and weaker; in any event, it is exceptionally worn. Still, it is worth emphasizing that the superficial blues and blacks of the plumage are normal. The black bars on inner remiges and central rectrices are bold and of a spacing indicating rates of growth near average for the local population, but these of course are juvenal feathers whose growth was completed before the onset of the postjuvenal molt and therefore completed before or in spite of circumstances resulting in the curtailed molt. Fledglings are fed by parents for three or four weeks and occasionally longer after leaving the nest, and in any event until after the remiges and retrices are grown. These and retained juvenal coverts are dark basally. It appears likely that events leading to curtailment of molt occurred after the jay was fully grown.

The postjuvenal molt of Steller Jays in central coastal California normally ends in September or October. From color and wear characteristics of the exceptional specimen reported here, there is no suggestion that its molt stopped significantly later. Nor is there any sign that molt was protracted with replacement proceeding at a low rate through the nonbreeding months as is known to occur in some subtropical jays (for example, *Cyanocorax yncas;* Pitelka, MS). There is no evidence of adventitious replacement, even on the legs where the worn and weak feathers are evidently all of one generation.

A possible clue to curtailment of molt and the subnormal energy resources during molt suggested by this, by the reduced melanin, and by sparseness of plumage is a malformed lower mandible. It appears that a distal break of the left ramus healed, but left the mandibular symphysis broader than normal so that distally the horny sheath exceeds the width of the upper mandible. Moreover, distally the lower mandible is twisted slightly to the left. The bird could therefore neither cut nor pound effectively. Its bill is exceptionally long, measuring 25.3 mm as against

21.40 ±0.54 (range 20.2-22.0) in 10 first-year males from central coastal California taken in the months of December through April. The specimen showed no fat (weight not taken). The testis measured only 3 mm indicating nonbreeding. It was alone and quiet when collected in a redwood grove. Other Steller Jays were present in the area; the species is a common resident locally.

From studies of this and other species of American jays, it can be said that the basic geography of molt spread over the body is very similar among them notwithstanding wide-ranging differences of latitude and climate. The main differences come in timing and in extent of postjuvenal molt. It is of interest that in curtailment of molt in the Santa Cruz specimen described here, those features common to races or species of lower latitudes occur. The additional features that it shows raise the question as to whether it was under metabolic strains during molt greater than those inferred to be more usual to more southern jays and presumably responsible for the fact that their less extensive and more variable postjuvenal molt also takes longer. The Santa Cruz specimen thus gives us some suggestion of molt characteristics for individuals in populations in which factors curtailing molt could be aggravated by the more compressed schedule of the molt as a whole for that and other more northern populations.—FRANK A. PITELKA, *Museum of Vertebrate Zoology, University of California, Berkeley, California.*

Favorite Foods of Neotropical Birds: Flying Termites and *Cecropia* Catkins.—On recent visits to Panama I have noted two food sources that attract a wide variety of birds, seemingly without regard to whether they are primarily insectivorous or vegetarian.

Flying termites. Colonies of termites (Isoptera) are conspicuous in the tropics, but they seem generally well protected from bird predation. While certain trogons, puffbirds, and parrots dig nest holes in arboreal termiteria and have been reported eating the exposed termites, I have yet to see a bird opening the termite passageways that are so abundant on tree trunks in the tropics. I suspect that most birds do not seek ordinary termites as food any more than they do the worker ants. Periodically, however, broods of sexually active, winged males and females are produced, which take to the air in swarms for their nuptial flight. These termites are enormously attractive to birds. The specially nurtured brood may well be more nutritious than the worker caste fed on wood pulp or other relatively indigestible material. On 11 May 1961, near Gatun Dam, Panama Canal Zone, James E. Ambrose, Jr., and I were surprised to see a large variety of birds sallying out into the air, evidently "flycatching." The time was 1300, a time of day when there is usually a minimum of activity. We were in a cleared area, adjacent to a building, partly bordered by second growth. The attraction was a swarm of winged termites. A slight drizzle indicated the beginning of the rainy season. In the course of about 20 minutes we noted from one spot 16 species of birds catching termites in the air: Tyrannidae—Tropical Kingbird *(Tyrannus melancholicus)* 1, Piratic Flycatcher *(Legatus leucophaius)* 2, Streaked Flycatcher *(Myiodynastes maculatus)* 2, Social Flycatcher *(Myiozetetes similis)* 1, Great Kiskadee *(Pitangus sulphuratus)* 1. Hirundinidae—Brown-chested Martin *(Phaeoprogne tapera)* 3, Rough-winged Swallow *(Stelgidopteryx ruficollis)* 2. Mimidae—Tropical Mockingbird *(Mimus gilvus)* 2. Turdidae—Clay-colored Robin *(Turdus grayi)* 1. Coerebidae—Red-legged Honeycreeper *(Cyanerpes cyaneus)* 1. Thraupidae—Blue-gray Tanager *(Thraupis virens)* 1, Palm Tanager *(Thraupis palmarum)* 1. Fringillidae—Variable Seedeater *(Sporophila aurita)* 2,

Yellow-bellied Seedeater *(Sporophila nigricollis)* 2, Blue-black Grassquit *(Volatinia jacarina)* 2, Green-backed Sparrow *(Arremonops conirostris)* 1. Later that same afternoon at Fort Davis, Canal Zone, along a wide trail in second-growth woods, we observed a Black-bellied Wren *(Thyrothorus fasciato-ventris)*, ordinarily a sulking, undergrowth species, flying out to catch winged termites of apparently the same kind. Of the birds mentioned, catching insects in flight was normal only for the Tyrannidae and the Hirundinidae. The Tropical Kingbird was especially adept, coursing back and forth in the air much like the swallows. The short-winged mockingbirds and the fringillids seemed to have difficulty maintaining themselves in their aerial sallies. The seed-eaters and grassquits feed as adults primarily on grass seed, and they were not yet nesting (or even singing) in this area. The honeycreeper is essentially a nectar and fruit eater, and the tanagers are mainly frugivorous. The tyrannids, robin, and mockingbird were all probably nesting nearby, but they appeared to be swallowing their prey.

Cecropia catkins. Among the most characteristic plants of the Middle American tropical lowlands are the trees of the genus *Cecropia* (generally called *guarumo*). Though rather small and scrawny, the trees are distinctive: a slender, smooth, whitish or pale green trunk, forks at the top into a few bare branches, from the tips of which grow large, deeply-lobed, peltate leaves. They are among the first trees to appear in a newly made clearing, but do not survive in the shadow of a canopied forest. Few trees in Panama are so favored by birds. Their bare, almost horizontal, branches are used as lookouts by many species and even more find their fruit attractive. This seems strange, for the fruit is not juicy, sweet, or colorful. The fruiting bodies are long, pendant, fingerlike aments or catkins (20-40 centimeters long in *C. mexicana*), clustered together on a peduncle near the place where the tree branches. The birds eat the tip of the rather green fruiting spike, which to my palate is dry and insipid. Yet it must be nutritious to mammals. On Barro Colorado Island, at the edge of the clearing of the biological station, I have frequently watched White-faced Capuchin Monkeys *(Cebus capucinus)* nibbling at one catkin tip after another, and at night seen Kinkajous *(Potos flavus)* and, once, even a Woolly Opossum *(Philander laniger)* similarly engaged. The leaves of *Cecropia* are said to constitute the principal food of the Three-toed Sloth *(Bradypus griseus)*, and I have repeatedly noted Tayras *(Tayra barbara)*, large, partly frugivorous, members of the weasel family, on *Cecropia* trees. The hollow trunks of these trees are inhabited by biting ants, but they seem to cause no inconvenience to the birds and mammals. In the course of three afternoons, 21-23 August 1954, I noted 13 species of birds eating the tips of the *Cecropia* catkins of a single tree (which I identified as *C. mexicana*) at the border of the clearing at Barro Colorado Island. In subsequent visits to the island additions have been made to the list. As will be noted, some of the species, notably the woodpeckers, belong to families that are distinctly insectivorous.

Columbidae—Short-billed Pigeon *(Columba nigrirostris)*. Psittacidae—Orange-chinned Parakeet *(Brotogeris jugularis)*. Trogonidae—White-tailed Trogon *(Trogon viridis)*. Ramphastidae—Collared Araçari *(Pteroglossus torquatus)*; Keel-billed Toucan *(Ramphastos sulphuratus)*; Chestnut-mandibled Toucan *(Ramphastos swainsonii)*. Picidae—Black-cheeked Woodpecker *(Centurus pucherani)*; Crimson-crested Woodpecker *(Phloeoceastes melanoleucos)*. Cotingidae—Blue Cotinga *(Cotinga nattererii)*; Purple-throated Fruitcrow *(Querula purpurata)*. Tryannidae—Streaked Flycatcher *(Myiodynastes maculatus)*; Boat-

billed Flycatcher *(Megarynchus pitangua)*. Coerebidae—Green Honeycreeper *(Chlorophanes spiza)*; Red-legged Honeycreeper *(Cyanerpes cyaneus)*; Blue Dacnis *(Dacnis cayana)*. Icteridae—Chestnut-headed Oropendola *(Zarhynchus wagleri)*. Thraupidae—Fulvous-vented Euphonia *(Tanagra fulvicrissa)*; Golden-masked Tanager *(Tangara larvata)*; Plain-colored Tanager *(Tangara inornata)*; Blue-gray Tanager *(Thraupis virens)*; Palm Tanager *(Thraupis palmarum)*. Fringillidae—Variable Seedeater *(Sporophila aurita)*.

This list is certainly far from complete. Skutch (1960. *Pac. Coast Avif.*, 34: 68, 453) mentions two other common Middle American species seen feeding on the *Cecropia* aments: Piratic Flycatcher *(Legatus leucophaius)* and Clay-colored Robin *(Turdus grayi)*. Invariably, in my experience, the birds eat only the tips of the catkins—moving from one to another. The smaller species hang upside down on the catkin as they peck at it; the larger species usually perch on the peduncle and bend down to get at the fruit. But the flycatchers and trogons bite at the fruit in flight. Once I saw a Plain-colored Tanager (which ordinarily perches on the catkin) whirling below as it hung by its bill from the tip of the spike.—EUGENE EISENMANN, *American Museum of Natural History, New York 24, New York.*

New Records in Micronesia for the Bar-tailed Godwit and Black-crowned Night Heron.—The Bar-tailed Godwit, *Limosa lapponica baueri* (Naumann), has been frequently recorded from the Western Caroline Island archipelago and as far eastward as the Atoll of Truk (7° N lat, 152° E long) in Micronesia. Transients moving to or from arctic breeding ground travel generally along the Asiatic Coast, but stragglers have been reported as far off course as Hawaii. The possibility of the species reaching the Eastern Carolines has been considered likely but has remained unconfirmed. On the evening of 3 April 1958, Dr. Kyle Barbehenn, of the Pacific Island Rat Ecology Project, and I collected two specimens of this bird on Napali Island, Metalanim harbor, on the east-coast reef of Ponape (7° N lat, 158° E long), which lies some 620 km (358 miles) east of Truk. The birds were feeding on a sandy beach facing the lagoon. One skin prepared was a female and is now No. 225087 in the collection of the U.S. National Museum.

The Black-crowned Night Heron, *Nycticorax nycticorax nycticorax*, has been reported by various observers from the Marianas Islands and in the Caroline Archipelago from Palau, Yap, Ulithi, and eastward as far as Truk. On 30 October 1957, Dr. Kyle Barbehenn collected an immature male of this species at Ponape Island. The specimen was devoid of fat. This specimen is now in the collection of the U.S. National Museum, No. 217465.

This places the known range in Micronesia of both *N. n. nycticorax* and *L. lapponica baueri*, during migration, almost 650 km (400 miles) farther eastward than previously recorded.

Mr. Herbert G. Deignan, of the Division of Birds, U.S. National Museum, kindly confirmed the identifications (pers. comm. 8 January 1960).—JOHN H. BRANDT, *Truk, East Caroline Islands.*

First Tufted Duck Seen in Oregon.—On 14 February 1960 I discovered a male Tufted Duck *(Aythya fuligula)* with eight Ring-necked Ducks *(Aythya collaris)* on the Laurelhurst Park pond in Portland, Oregon. The latter were part of a wintering population of at least 40 birds known to frequent several such ponds on the east side of the Willamette River inside the city limits.

Subsequent trips were made to the park with the following results: 16 February, 0830: the bird was diving for cracked corn put out by the park attendant; 20 February, 1630: present with 12 Ring-necked Ducks; 27 February, 1500: present with 12 Ring-necked Ducks; 5 March, 1500: pond frozen over and neither species present; 12 March, 1100: present with 16 Ring-necked Ducks; 20 March, 1000: one pair of Ring-necked Ducks only; 26 March, 0900: present with a male Ring-necked Duck; 9 April, 1630: neither species present in any of the usual haunts. The bird was separately identified during its stay in Portland by David B. Marshall, Wildlife Management Biologist of the Malheur National Wildlife Refuge (who also photographed it); Tom McAllister, Jr.; Norbert Leupold; and John B. Crowell, Jr.—all experienced local ornithologists.

The A.O.U. *Check-list of North American Birds* (5th ed., 84, 1957) includes records from Greenland and from Newburyport and Marshfield, Massachusetts; at least the latter of which is presumed to have escaped from a game farm. Gabrielson and Lincoln (*The Birds of Alaska*, 188, 1959) record a female taken of a pair on St. Paul Island in 1911 by Evermann and two pairs seen at Murder Point, Attu Island, by Wilson in 1945. The probability that this bird escaped from a private estate has been explored with inconclusive results. There are few such places in the Northwest, and I know of none that raise any exotic species. Consequently, it seems likely that if it were an escapee, it had come some distance from its point of origin.—JAMES G. OLSON, *2740 Elinor St., Eugene, Oregon.*

[Editor's Note: The photograph taken by David B. Marshall clearly identifies this bird as *Aythya fuligula*. Unfortunately a reproduction of the photograph of suitable quality for printing has not been possible. D. S. F.]

A Record of the Yellow Rail from Dallas County, Texas.—The Yellow Rail *(Coturnicops noveboracensis)* is one of the most elusive and secretive birds during migration. The paucity of records from Texas agrees with this and prompts the writer to report an unusual occurrence of this species in Dallas County, Texas.

For the past three years I have been carefully checking for bird casualties at the 500-meter (1,520-foot) KRLD and WFAA-TV tower, just west of the town of Cedar Hill, Texas, about 30 km (18 miles) southwest of Dallas in the southwestern part of Dallas County. On the morning of 16 October 1960, the personnel on duty at the Cedar Hill TV tower notified me that a large number of birds had been killed during the night of 15-16 October. Upon arrival at the WFAA-TV station I was presented with a live Yellow Rail that apparently had been only stunned.

During the course of picking up over 500 birds of 37 species, my son and I picked up 13 Yellow Rails. Six of these were prepared as specimens, four were disposed of because they were so badly damaged, and three still alive were banded and later released in the White Rock Lake area, within the northeastern part of the city of Dallas. The live rails were hiding amongst dried grass, but made no sound or attempt to fly upon being picked up. The occurrence of these rails is the first record of this species for Dallas County.

All of the rails, which were prepared as study skins, were fat; four were females and two were males. Deposition of the specimens was as follows: one of the females was presented to Dr. George M. Sutton of the University of Oklahoma, a pair was given to Dr. Allan R. Phillips of Mexico City, and the remainder are still in my possession.

Among the members of the family *Rallidae* that were picked up on this same date were a Virginia Rail *(Rallus limicola)* and an American Coot *(Fulica americana)*. Rails included in previous kills were Sora *(Porzana carolina)* and coots.

It is interesting to note that there were no rails found among the 106 bird casualties that were picked up for me by friends, on 16 October 1960, at the WBAP-TV tower in the Meadowbrook area, within the eastern part of the city of Fort Worth, Tarrant County. This tower is only 250 meters (750 feet) high, and approximately 48 km (30 miles) from the Cedar Hill TV tower.—WARREN M PULICH, *Department of Biology, University of Dallas, Dallas, Texas.*

***Dendroica dominica stoddardi* from South Carolina.**—Recently, while examining some warbler skins in the Charleston Museum collection, my attention was attracted by an unusually long and slender-billed male Yellow-throated Warbler (No. 53FF). This bird had been collected by the late Arthur T. Wayne near Mount Pleasant, South Carolina, on 9 January 1912. The exposed culmen measured 15 mm. The skin was sent to George M. Sutton, who, under date of 9 March, wrote that it was unquestionably stoddardi. My thanks are due to Dr. Sutton; also to Mr. E. Milby Burton, Director of the Charleston Museum, for the privilege of recording the bird.—EDWARD VON SIEBOLD DINGLE, *Huger, South Carolina.*

A White-winged Scoter Specimen from Alabama.—Although the White-winged Scoter *(Melanitta deglandi)* may have always occurred sparingly in Alabama, it is not listed in A. H. Howell's *Birds of Alabama*, published in 1928. In recent years there have been several sight records, both coastal and interior. Interior records seem limited to those kept by the Wheeler National Wildlife Refuge and include both observations made on the refuge and those made on nearby portions of Wheeler Reservoir. These include an observation at the Flint Creek Embayment of the refuge on 21 December 1942 by Ernest Holland. On that same date John Steenis, a U.S. Fish and Wildlife Service biologist, and Paul Bryan, a TVA biologist, examined a female White-winged Scoter killed by a hunter on Swan Creek, a short distance west of the refuge boundary, but the specimen was not preserved. On 2 November 1954 David C. Hulse of Decatur saw a female White-winged Scoter near the Decatur Boat Harbor. No Alabama scoter specimen was preserved until James Call shot a young female White winged Scoter on 10 December 1960 in the Wheeler Reservoir backwaters of Limestone County immediately north of the city of Decatur. Call gave the specimen to David Hulse, who turned it over to Wheeler Refuge personnel. After positive identification this was given to the Alabama Conservation Department, mounted by Robert Skinner, and is now included in the department's collection as specimen B-316.—THOMAS Z. ATKESON, *Wheeler National Wildlife Refuge, P.O. Box 1643, Decatur, Alabama.*

Cattle Egret in Mexico.—The Cattle Egret *(Bubulcus ibis)* is a species with a remarkable ability for range expansion. In a very few years it has become established along the Atlantic coast from Maine to Florida as well as at numerous places inland and is a breeding species from Florida to central Texas (Davis, *Auk*, 77: 421-424, 1960). In addition it is probably well established in Mexico. While in the state of Tabasco with Dr. T. C. Meitzen and Joe Johnson of

Refugio, Texas, both competent ornithologists, I observed Cattle Egrets at two different localities. On 13 April 1961 we saw 11 about 75 km (45 miles) southeast of Villa Hermosa, Tabasco. The birds were about 15 meters from the road in a swampy pasture with a herd of cattle. Some were perched on the back of a cow, and others were on the ground scattered among the herd. Later the same day we observed 11 more about eight km (five miles) farther east, but these were possibly the same birds. On 14 April 1961 two Cattle Egrets were seen on the backs of cattle about 10 km (six miles) east of Villa Hermosa. Again, on 17 April 1961, five Cattle Egrets were seen about 12 km (seven miles) north of Tampico, Tamaulipas. These were also in an open pasture scattered among a herd of cattle. No specimens were taken, as the yellow bill, buffy crown, and buff along the back precludes confusion with any other species. Cattle Egrets have been reported in Guatemala by Smith and Land (*Auk*, 77: 218, 1960) and in Quintana Roo by Denham (*Auk*, 76: 359, 1959), but these are believed to be the first records for Tabasco and Tamaulipas.—Col. L. R. Wolfe, *Kerrville, Texas.*

Recovery of Bird Band from an Owl Pellet.—On 18 January 1961, while repairing goose nesting islands in Pool 1 at the Shiawassee National Wildlife Refuge, Saginaw, Michigan, a large, freshly regurgitated owl pellet—presumably a Great Horned Owl *(Bubo virginianus)*—was found on one of the islands. Upon examining the pellet, a Fish and Wildlife Service bird band, No. 546-35934, was found. No mechanical distortion of the band had occurred, and apparently it had been unaffected by the digestive processes. The band was attached to the leg of an American Coot *(Fulica americana)*. The leg, from the toes to the tibia, had been regurgitated intact. Freshly plucked feathers from a Ring-necked Pheasant *(Phasianus colchicus)* were found on the ground near the pellet.

It was found that the coot had been banded at the refuge 13 September 1960. Presumably the coot was one of a small number that remained on the refuge in a small, open-water area after freeze-up in December.—Ralph H. Town, *Shiawassee National Wildlife Refuge, Saginaw, Michigan.*

Loss of 1,000 Lesser Sandhill Cranes.—On 10 November 1960 Don Price, Wildlife Conservation Officer from Clovis, and I observed a number of dead Lesser Sandhill Cranes *(Grus canadensis canadensis)* along State Highway 330 north of Elida, New Mexico. These birds were in a badly decomposed condition, and the cause of death could not be determined. At first we believed the birds had been killed either by poachers from the nearby highway or by coyotes, which are numerous in this area. Additional investigations into these losses revealed 15 more dead birds around a windmill stock tank on the Jake McCabe ranch. Mr. McCabe was contacted, and he stated that a hailstorm on 15 October had killed these birds. While talking he pointed out numerous House Sparrows *(Passer domesticus)* in his yard that had also been killed. He said the storm began about 0330 and lasted for approximately 30 minutes. He also mentioned that additional dead cranes could be found around Lewiston Lake also located on his property. We made a trip to this lake, but did not arrive until after sundown, and no count of dead birds could be made.

On 15 November Charles Q. Heumier, U.S. Game Management Agent of Roswell, New Mexico, and I returned to Lewiston Lake and walked around part of the shoreline where the largest concentration of dead birds appeared. We counted 720 dead cranes. Many of the birds had been dragged from the shoreline

into the brush surrounding the lake. This appeared to be the work of coyotes, which were frequently seen during the investigation. On 23 November a survey was made in the Game Department aircraft. Many dead cranes were observed on the prairies up to a mile away from the lake. Additional dead cranes, not previously counted, were observed on the shoreline of Lewiston Lake. From this flight and from previous counts we estimated that the actual loss exceeded 1,000 cranes.—GEORGE W. MERRILL, *New Mexico Department of Game and Fish, Santa Fe, New Mexico.*

Observation of Avian Pox in a Yellow-shafted Flicker.—Avian pox, a viral infection manifested in both cutaneous and diphtheritic forms, is a common disease among domestic and wild birds (Cunningham, C. H., 1952. *In* H. E., Biester and L. H. Schwarte, Ed., *Diseases of Poultry*, Chap. 25. Iowa State Coll. Press, Ames. 1,245 pp.). The writers collected a live, female Yellow-shafted Flicker *(Colaptes auratus)* near Donovan, Illinois, on 29 April 1960, which showed cutaneous, wartlike lesions on the right eyelid (Figure 1). This infection was histopathologically diagnosed as avian pox by the diagnostic laboratory, College of Veterinary Medicine, University of Illinois. The bird was capable of manipulating its eyelid despite the large lesions, and seemed to exhibit normal vision. Lesions, other than those on the eyelid, were not found on this bird. No attempt was made to isolate the strain of virus causing this pox infection. To the best of our knowledge, the infection of Yellow-shafted Flickers by avian pox has not been previously reported *in litt.*—RONALD F. LABISKY *and* STUART H. MANN, *Illinois Natural History Survey, Urbana, Illinois.*

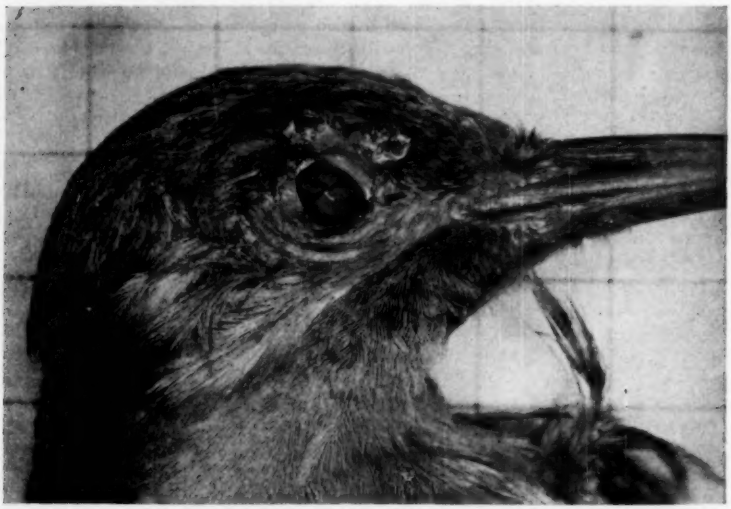

Figure 1. Avian pox, manifested in cutaneous, wartlike lesions, on the eyelid of a female Yellow-shafted Flicker. Photograph by William E. Clark, Illinois Natural History Survey Photographer.

A Method of Netting Birds at Open Nests in Trees.—This note describes the use of a small hoop net, resembling a butterfly net, as a device for catching birds at open nests in trees and shrubs. The method is simple and highly effective. Despite its simplicity it appears not to have had any general use.

Information from personal inquiries and published papers indicates that many ornithologists have difficulty in capturing tree-nesting birds. However, after I had devised and used a hoop net, I learned that Lawrence H. Walkinshaw had been employing the method for many years. Thus the procedure described here is not new, although it is original.

Unless otherwise indicated, references to birds are to Prairie Warblers *(Dendroica discolor)*, about 100 of which I have caught in hoop nets. I have also used the device to catch small numbers of Bell's Vireos *(Vireo bellii)*, Indigo Buntings *(Passerina cyanea)*, American Goldfinches *(Spinus tristis)*, and Field Sparrows *(Spizella pusilla)*. Birds have been taken at heights ranging from about one to six meters.

A net suitable for catching small birds has a hoop about 35 to 45 cm (15 to 18

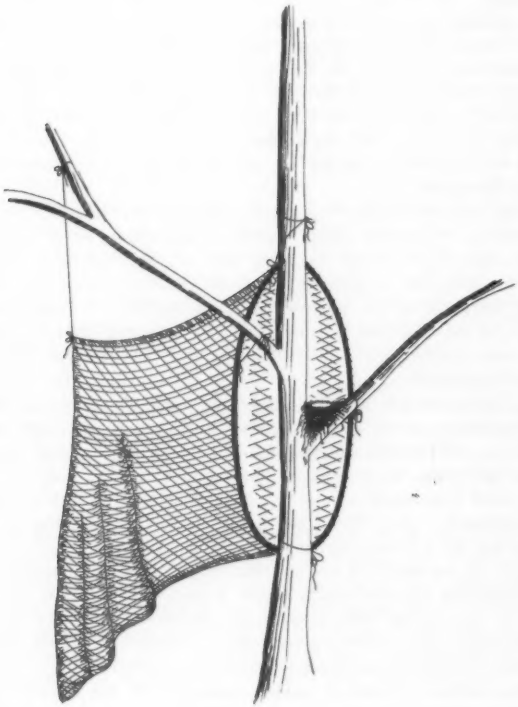

Figure 1.

inches) in diameter, made of wire pliant enough to allow some shaping to fit the situation at each nest. Coat-hanger wire serves well. A bag made from ordinary fine mist netting is laced to the hoop and sewed together to form a pocket about 60 cm (24 inches) deep. It is preferable to cut the bag so that it is roomy and square at the end rather than narrow and tapering.

The net is placed in such a way that the nest is in the center of the hoop, just at or inside the mouth of the bag, as shown in Figure 1. The hoop is pulled well under the nest, if possible, to catch the bird if it drops downward on leaving. Neutral-colored yarn, which can be broken with the fingers of one hand when the net and the captured bird are removed, is used to tie the hoop in position. Several lengths of yarn are fastened to points around the hoop before the nest is approached; the yarn at the top of the hoop is tied to the tree first, and a sufficient number of other lengths are then fastened to the tree to hold the frame rigid.

The position of the bag is critical. It should extend backward from the hoop parallel to the ground for the first half or two-thirds of its length, and the remainder of it, *i.e.*, the closed end, should hang slack. The bird can then enter the bag easily but will work its way into the drooping, closed pocket, where it will hang indefinitely. In contrast, a bird may not get far enough into a net that hangs slack straight from the hoop, and escape is equally possible from a bag whose entire length is horizontal and taut. To prepare the site for the net all intruding vegetation is cut off or tied back. Fine, dark thread, tied to the bag itself, is used to hold the bag in the desired position. Except on very windy days, I have found one thread, tied at one end to the top of the bag and at the other end to overhanging vegetation, sufficient to hold the net in place. Figure 1 illustrates how the bag is suspended from the thread and hangs slack beyond the point of attachment of the thread.

The principal variation from the foregoing general instruction is required when nests are built in herbaceous plants, against grass stems, or in other situations providing no supports to which the hoop may be tied. In these cases artificial support for the hoop can be provided by a cut sapling selected for its suitability in shape and sharpened at the base so that it can be stuck into the ground at the nest site. As in all instances in which one can anticipate that he must alter or prepare the area immediately surrounding the nest, the changes should be made gradually and in advance.

Experience indicates that the net can be put up in from one to two minutes, during an inattentive period of the adults. Birds returning to the nest for the first time occasionally show some uneasiness if the netting is blowing in the wind or if the sunlight glints on the net or wire; but none have ever deserted, and I have never found camouflage necessary. It is clear that the net is almost always detected immediately. Only twice has a bird flown into the bag in the normal course of leaving the nest and without my having frightened or driven it; on both these occasions the net had been put up immediately before the capture. Therefore, once the investigator sees the adults depart from the nest a time or two without flying into the net, he can with considerable assurance leave the device in place and make the catch later at his convenience. I sometimes put the net up several days in advance but tie the bag closed or pull it out of position.

Making the capture requires a sudden movement in the direction of the nest from the side opposite that toward which the bird must fly to enter the hoop. Details of the procedure will depend upon the height of the nest, the stage of nesting, and the sex and degree of timidity of the bird to be caught. When a

bird is too timid to allow a close approach or when it is likely to be at the nest only briefly (building, feeding), the investigator can withdraw a few meters with no loss of effectiveness, if he trims a long sapling of all but a few leaves at the top and holds this before him when he runs at the nest, thus extending his reach. Similarly, a bird sitting on an overhead nest can be startled off by one's suddenly erecting such a sapling above nest height and waving it toward the nest. Under some circumstances, *e.g.*, at high nests, it may be necessary to make the startling movement by means of a nearby branch that has been pulled back under tension; when the tension is released the branch snaps toward the bird at the nest. In all cases, the angle of approach to the nest is important and should be determined with knowledge of the direction in which the bird is facing and the probable degree to which its line of departure may be deflected.

Removal of the captured bird without danger of its escaping or being injured usually requires that the net be taken down. The bird is grasped in one hand from outside the bag, and the threads and yarn tying the apparatus in place are broken with the other hand. I prefer to extricate the bird from the netting by cutting two or three strands and pulling it through from the outside, then repairing the net immediately.

Desertions of nests by captured birds of all species have amounted to about 2 or 3 per cent and have never occurred after the first day or two of incubation. Risk of desertion has been eliminated by the introduction of a nestling into the nest, a practice that has the additional advantage of causing the male to initiate feeding and thus to be vulnerable to immediate capture. If the introduced nestling is removed from the nest at the time the adults are caught, they are likely to desert. However, the young bird can be taken surreptitiously a day or two later, and the female will then resume incubation. A discussion of the tolerance of birds to this sort of manipulation is reserved for a later paper (see Emlen, *Condor*, 43: 209-219, 1941), but it should be noted that the utility of the hoop net is greatly increased by the fact that Prairie Warblers accept and feed nestling Indigo Buntings, Chipping Sparrows *(Spizella passerina)*, Field Sparrows, and, of course, Brown-headed Cowbirds *(Molothrus ater)*. Indigo Buntings and Field Sparrows also accept young Prairie Warblers.

A comparison of the foregoing procedures with the brief description by Walkinshaw of his method of catching Field Sparrows in a minnow seine (*Bird-Banding*, 10: 107-114; 149-157 at 153-154, 1939) will reveal no differences in principle. Further, in a letter to me on 30 July 1959 Walkinshaw stated that he had more recently used women's hair nets to capture birds at nests. It is almost certain that others have developed similar nets.

The advantages of the method described here may be summarized by contrasting it with the use of the mist net. The hoop net is a selective trap for nesting birds. It can be sprung at the investigator's convenience, is easily set, and requires no cutting of swathes through vegetation. Its effectiveness is not limited to windless days, nor is it important that it escape detection by the bird to be caught. Usually the net can be set up at any height to which it can be carried, and it is easily portable in a plastic or paper cover that protects it from snagging.

I wish to thank Andrew J. Berger and Lawrence H. Walkinshaw for reading this note in manuscript.—VAL NOLAN, JR., *Indiana University, Bloomington, Indiana.*

Aerial Pursuit of Hawks by Turkeys.—Observations of wild Turkeys *(Meleagris gallopavo)* protecting their young from predators on the ground are not uncommon. However, I know of no published accounts of Turkeys actually taking flight to chase birds of prey. Such an occurrence of aerial pursuit was observed at the Peterson Ranch (at the head of Workman Creek) in the Sierra Ancha, Gila County, Arizona, on 4 August 1960, by Gene Seeley and Mike Stapley, U.S. Forest Service employees, who were watching two Turkey hens with poults in a clearing when a "large, dark hawk" flew into view. The hens gave a warning sound, and the poults (which were about one third grown) ran toward nearby cover at the edge of the clearing. The poults reached cover just as the hawk made an initial, unsuccessful dive at them. The hawk then circled and made a second pass but this time was met (at a height of approximately six meters above the ground) head-on and knocked to the ground by one of the hens. The hawk then flew into a nearby tree.

One of the hens flew from the ground toward the tree in which the hawk had perched, whereupon the hawk dove toward the poults and the hen that was on the ground. Again the hawk encountered a hen in the air and returned to a tree only to be chased out, as before, by one of the hens. After a "few minutes" the hawk retreated, minus several wing and tail feathers.

The hawk, judging from the description given to me, was a Zone-tailed Hawk *(Buteo albonotatus)*. On 9 August I saw one member of the pair of Zone-tailed Hawks, which had a nest in a large ponderosa pine tree (downstream from the Peterson Ranch), soaring above the scene of the Turkey-hawk fight. Several feathers were missing from the wings and tail, and this made me wonder if this hawk was the one that had encountered the Turkey hens.

I know of only one other similar incident, which also occurred in central Arizona. Reginald Reynolds, Pleasant Valley Ranger, Young, Arizona, told me that he once watched a Turkey hen fly in pursuit of a Red-tailed Hawk *(Buteo jamaicensis)* that endangered her poults.—R. Roy Johnson, *Museum of Natural History, University of Kansas, Lawrence, Kansas.*

Peregrine Falcon Hunting Bats While Wintering in Brazil.—The well-known behavior of the Peregrine Falcon *(Falco peregrinus)* to retire only when darkness has almost set in should afford this raptor opportunity for bat hunting. In spite of this there is very little evidence of bats being taken and few observations on the manner in which this falcon catches bats (*e.g.*, Stager 1941, *Condor*, 43: 137, Observations in Southern Texas).

As already stated (*Publ. Avuls.* 34, Mus. Nac. Rio de Janeiro, 1960: 10), I have suspected for some time that the Peregrine Falcon pursues bats in Brazil. In 1960 I succeeded in making some definite observations.

A flock of bats selected for their diurnal shelter the bottom of a slab protruding from one of the many rocks that tower over the city of Rio de Janeiro. At dusk the bats were leaving their shelter flying so thickly bunched that, from a distance, they resembled a cloud of smoke driven by the wind; they kept together as long as they remained visible through my binoculars. Their number was usually about 500.

An old Peregrine Falcon, which had discovered their roost, used to come as the sun was setting, using as his post a *Cecropia* tree that was growing one-third of the way down from the top of the rock wall. This tree, which is typical of the

tropical zone of South America, has long and bare, horizontal branches, which afford easy opportunity for landing and take-off and a commanding view of hunting territory.

As soon as the first bats appeared, the Peregrine Falcon dove at them. Sometimes a catch was made at the first attempt, quite near to the wall. The hawk would then return to his tree and eat his prey. This required about five minutes. He usually ate with his back in the direction where the bats were leaving. After finishing he would jump to another branch facing the bats, ready to attack again. This would happen often enough whenever the bats departed in two or three groups.

Between 2 and 24 March 1960 I made 10 observations. On eight days I observed hunting of bats; on one day I only saw the falcon at his post but could not wait for the hunt. Only once did I come in vain. This was on a rainy evening during which the bats did not leave their shelter.

The great speed of the action and the fading light prevented observation of possibly interesting details. Most observations could only be made against the light, evening sky. At each time it was definitely noted that the falcon threw itself into the stream of bats. The best indication of a successful hunt was the falcon's return to the *Cecropia* tree. At times it was noted that the flying Peregrine lowered his head and raised his feet, probably killing with one bite the still-struggling bat. Once, I discovered a bat wing on the silhouette of the returning bird.

When the first attack was not immediately successful, the hawk would fly with the stream of the bats, which, as mentioned before, would stick together for a long while and which the falcon hardly dispersed. Although I could only see the rear of the bird and that from ever-increasing distances, his short and rapid turns indicated that he was continuing the chase. It was always noted that the Peregrine Falcon only chased bats flying in the flock and not those flying singly. Even then, the hunt was not always successful. Once, as if playing, the bird only followed the bats without making a real attack; he soon left and flew off, not returning to his *Cecropia* tree, although the bats continued to leave from their hiding place for another four minutes.

Once, on 6 March 1960, another Peregrine Falcon appeared after the first one had already caught one bat. The two raptors, which were of markedly different size, chased each other in a playing manner. A harsh, shrill chattering and an occasional, deeper *ga-ga-ga* could be heard. No more interest for bats was shown. The second falcon departed soon, and the first one returned to the rock wall. In the meantime the bats had all left, and night had almost fallen.

I was not able to ascertain whether the Peregrine Falcon used the *Cecropia* tree for sleeping also. It may be that he left for some shelter in the rock after darkness set in. My observations were made more difficult as I had to avoid drawing the attention of people living nearby. The falcon had become famous in Rio de Janeiro in the preceding year as a pigeon chaser (several individuals were then observed, *vide op. cit.*), and there was a clamor for its extermination. This would have been easy at the rocky wall. Apparently, his activity on this spot had not been noted—amazingly enough as the snowy-white belly of the big bird sitting in the *Cecropia* tree could be seen from a great distance at dusk. His regular hunting activities should also have become noticeable. One of the residents told me that he had at least noticed the bats, which he thought to be sparrows! In

order not to endanger the falcon by being discovered, I refrained too from looking for remains of bats at the bottom of the rocky wall. Thus, I am unable to state the species of the bats involved.

The observed bird was definitely one individual only. Weather permitting, it is likely that the falcon came every day, probably starting before 2 March, the day on which I discovered the bat roost. He also probably continued after 24 March. I had to leave Rio de Janeiro on 25 March for one month. When I returned on 22 April, I saw the Peregrine again at his post. This was unexpected, as I have usually only observed the species in Rio up to the middle of March and once at the beginning of April (5 April 1958). However, at that time I did not know of as favorite a spot as the one near the bat roost, which might have enabled me to make more accurate observations about the length of his stay in this region.

The date of 22 April 1960 appears to be of some significance. In spite of daily visits I did not see the bird again during that season. The next time I observed a Peregrine Falcon near this spot was on 5 October 1960. However, up to 20 January 1961, no falcon was seen by me on the *Cecropia* tree, nor did I notice any bat hunting in spite of frequent searches.

It may be added that I have observed the Peregrine Falcon in Rio each year since 1950. The species was unknown here. In the literature I found only about half a dozen notes on observations in all of Brazil.—HELMUT SICK, *Fundação Brasil Central, Av. Nilo Peçanha 23 III, Rio de Janeiro, Brazil.*

BOOK REVIEWS

Biology and Comparative Physiology of Birds, Volume II.—Edited by A. J. Marshall. 1961. Academic Press, New York and London. x + 468 pp. $14.00.—The two volumes of this work provide an excellent, comprehensive, and up-to-date review of the biology of birds (Volume I, reviewed by T. R. Howell in *The Auk*, 78: 279-282). According to the publishers "the work is designed not only for ornithologists but also for other biologists who require specific information concerning any aspect of avian biology or physiology. In addition to the full treatment of the subjects, the references following each chapter form an excellent guide to the literature."

Volume II contains 12 chapters (XIII-XXIV), ranging in length from 18 to 74 pages. A wide range of topics is covered, but the emphasis tends to be on behavior and on reproductive physiology. The work is a quite advanced treatment, each chapter being written by a specialist who has been active in research work in the particular field he reviews. A detailed table of contents and an outline at the start of each chapter help keep the reader oriented. Most of the chapters are factual, well documented, quite clearly written, and historically minded. The names of the authors, together with their subjects, will give most ornithologists a good idea of the authoritative and scholarly nature of the work. Some remarks on each chapter in Volume II seem in order, continuing the sequence of the reviewer of Volume I.

XIII. The Central Nervous System, by A. Portmann and W. Stingelin, emphasizes brain topography and distribution of groups of nerve cell bodies. This chapter helps provide a solid foundation necessary for further understanding of the central nervous system in birds, but one is left with an essentially static picture, no doubt reflecting the primitive nature of current knowledge of the dynamics of the avian brain. The authors have devised a "cerebral index," which they have applied to many birds with the interesting suggestion that the relative mass of the cerebral hemispheres increases with the body weight in practically all groups.

XIV. Sensory Organs: Skin, Taste, Olfaction, and Equilibration, by A. Portmann, is also a primarily morphological account. One is impressed with the extent to which our knowledge of the structure of sense organs seems to have outpaced knowledge of their functioning, as for example, in the complex innervation of the skin of birds.

XV. Vision and Hearing, by R. J. Pumphrey, provides some very stimulating ideas, emphasizing the great speed of avian visual and auditory reactions, compared with those of man. Both structure and function are dealt with in some detail, but the subject is a very large one and the condensed account is a little vague in spots. Pumphrey's conclusion that most birds are probably not sensitive to sounds above 10 kilocycles seems unduly restricted.

XVI. Endocrine Glands, Thymus, and Pineal Body, by E. O. Höhn, excludes the gonads, since the latter are considered in subsequent chapters. This useful review, like Chapter XVIII, well illustrates the great extent to which current knowledge of the basic endocrine physiology of birds depends on the domestic fowl, pigeon, and duck. The chapter includes a good summary of the relationship between molting and shifts in endocrine balance.

XVII. Sex and Secondary Sexual Characters, by E. Witschi, considers the genetics and physiology of sex differentiation and also provides a very useful and stimulating summary and discussion of the mechanisms of endocrine control over

sex and seasonal differences in plumage, bill color, and special ornaments. Witschi emphasizes the role of the pituitary in the control of secondary sex differences in plumage and extends to certain other birds his conclusion, originally based on his investigations on weaverbirds (illustrated in color in the frontispiece of the book), that LH may in some birds stimulate male-type plumage independently of the gonads. Witschi describes Caridroit's demonstration that the henny plumage worn by the mallard drake during the summer is induced by the testicular hormone in the spring, but few ornithologists will accept his contention that this dull plumage should therefore be considered the true nuptial plumage of the species.

XVIII. Reproduction, by A. J. Marshall, deals with the anterior pituitary, gonads and accessory sexual organs, with special reference to reproduction. A great deal of literature is cited in support of this critical and modern account of a complicated subject.

XIX. Energy Metabolism, Thermoregulation, and Body Temperature, by J. R. King and D. S. Farner, is the longest chapter in the book. It is scholarly, quantitative, replete with helpful diagrams and useful tables, and cites over 200 selected references. The treatment emphasizes adaptations to the environment. One might wish that more than one paragraph (p. 267) had been devoted to discussing Allen's Rule and Bergmann's Rule.

The authors remark that a sufficient quantity of information has been accumulated now to indicate that the range of normal, adult, deep-body temperatures among the entire class is only of the order of six or seven degrees. No body temperatures are given for birds in flight, although one of the authors had actually accomplished this difficult feat of measurement on a wild species. The authors note (p. 258) Zeuthen's suggestion that the air sac system of birds may be of importance in the dissipation of heat during flight, and state that this aspect of thermoregulation deserves further investigation.

This chapter closes with a discussion of the recently analyzed phenomenon of temporary hyperthermia as an energy-saving device in certain goatsuckers, swifts, and hummingbirds.

XX. Flight, by R. H. J. Brown, considers the mechanics of flying in birds, and deals with both gliding and flapping. It is the shortest chapter in the book. Brown provides a good, basic, over-all organization and some significant and stimulating ideas, but the detailed explanations are very condensed and do not always seem to be as clear as they might be. Somehow the briefness of this chapter (18 pp.) does not seem entirely adequate for a phenomenon that is the central feature of avian biology. Only two papers less than 10 years old are cited, and one of these is on insect flight.

XXI. Breeding Seasons and Migration, by A. J. Marshall, describes the internal and external factors regulating breeding seasons and the impulse to migrate. This account is characterized by its broad viewpoint and research outlook with emphasis on and awareness of the gaps and uncertainties in our knowledge. Indeed, these attributes are, to a considerable degree, true of the entire book, no doubt in good part tracing to the editor and to his selection of authors.

XXII. Long-Distance Orientation, by the late G. Kramer, is a critical discussion and summary by a modern pioneer of this perennially favorite topic. Field experiments have shown that both directional orientation and goal orientation by migrating birds exist. Kramer summarizes the well-known experiments by himself and his associates on sun orientation, discusses the mechanisms of homing, ap-

praises the evidence for nocturnal orientation, and describes facts of visible migration as related to experiments.

As Kramer says (p. 352), "In the field of biology there is hardly another subject in which opinions have differed so greatly as on the question of homing orientation." He felt the G. V. T. Matthews' hypothesis that a bird can perceive the arc of the sun's movement within very short times and can quickly estimate the sun's elevation at noon (and thus estimate its latitude) had been disproved. Elsewhere in the book, Pumphrey (p. 58) holds that a bird can see so much faster than a man that it could easily perceive the arc of the sun's movement, although the sun might appear stationary to us. Throughout this chapter, Kramer recognizes the limitations of current information, and emphasizes that various observations all "indicate that there exist means of orientation still unknown to us."

XXIII. Behavior, by R. Hinde, is an excellent review and analysis of bird behavior from the customary viewpoints adopted by the European ethologists, *i.e.*, with emphasis on stereotyped behavior patterns, appetitive and consummatory behavior, sign stimuli and releasers. In addition, about half the chapter deals with various functional groups of activities—flocking, feeding, relations to predators, fighting, reproduction, and vocalizations.

Learning is recognized as entering into many phases of bird behavior, and ornithology seems destined to draw away gradually from the cliché that the behavior of birds is "almost entirely instinctive," although no doubt species-typical behavior depends ultimately and essentially on genetic differences between populations.

Bird behavior has been a popular subject for review, and this current treatment clearly reflects the trend toward a broad perspective and a synthesis of diverse viewpoints of various students of animal behavior, along with development of a simplified, objective, and consistent terminology.

XXIV. Bird Populations, by J. A. Gibb, discusses in a clear and well-documented way the measurement, growth, variation, and regulation of numbers of birds. "There is no easy or straightforward way of counting bird populations over extensive blocks of country, and various indirect methods have been used. . . ." Gibb stresses the importance of food supply and territorial relations in the regulation of population density, and draws attention to the relative neglect of the potential significance of autumn and winter territories in this regard.

At the end of Volume II there is an author index and a brief subject index. However, species of birds mentioned in the text are not included in the index.

There are numerous good illustrations throughout the text. Typographical errors are very rare but not absent (*e.g.*, Narler for Marler on p. 407), and errors of fact (Davis and Domm worked on chickens and not pigeons as stated on p. 196) seem likewise to be of minor and extremely rare occurrence. On the whole, each author discusses and attempts to give due recognition to the viewpoints of other qualified workers in his specialty when these views differ from his own.

Considering the large number of authors involved the book has remarkably good over-all integration and coverage. A little more information on the genetics of birds and more information on nests and nest building of birds would have seemed appropriate in a comprehensive survey of the biology of birds.

In conclusion, this work on the biology of birds meets very well a long-standing need for a modern and detailed account of ornithology in the English language. It will no doubt be highly useful to a good many biologists for a long time to come,

and the perspective furnished by it should greatly stimulate the further advance of ornithological knowledge.—NICHOLAS E. COLLIAS.

Bird Study.—Andrew J. Berger. 1961. John Wiley and Sons, Inc. xi + 389 pp., 178 figs.—There seems little point in attempting a comparison between this book and the other general, elementary texts on ornithology that have appeared recently. Despite the fact that the present work would not suffer from such a comparison, the scope of *Bird Study* warrants individual consideration.

This was not intended to be a definitive text on the subject. As specifically stated in the preface, it was written for use in a one-semester course for liberal arts students, in which Pettingill's *A Laboratory and Field Manual of Ornithology* would be used as a supplement. Accordingly, the author has permitted himself the luxury of a modicum treatment of morphology and physiology. A perusal of the "Contents" substantiates the implication, inherent in the title and spelled out in the preface, that the emphasis ". . . is on the living bird." The 11 chapters are headed, "Introducing the Bird," "Field Identification," "Bird Habits," "Migration," "Behavior," "Song," "Courtship and Nest Building," "Eggs and Young," "Structure and Function," "Conservation," and "Systematics." Eight pages of individual chapter references, 11 of "Common and scientific names of birds," and a 17-page index complete the book. The numerous illustrations are well chosen and generally very good.

The emphasis on behavior, both in the specific ethological and in the more general bionomic sense, may come as a surprise to those who consider Berger as primarily an avian anatomist. To preclude any suggestion that the book fails in the author's intent to supply a sufficiency of anatomical background for the purpose intended, we should note that in addition to the one chapter on structure and function, further morphological information is incorporated elsewhere, notably in Chapters one, six, seven, and eight.

Despite its intriguing aspects, the chapter devoted specifically to behavior was, for this reviewer, one of the least satisfactory in the book. This is not, necessarily, an indictment of the manner in which it was written. In fact, the calculated avoidance of anthropomorphic reasoning is extremely gratifying. Rather, this objection stems from the reviewer's impatience with the inane welter of terminology with which ethologists seem bent on duplicating some of the earlier aura of ecology. Readers unsympathetic toward the Lorenz-Tinbergen school, specifically, are not likely to enjoy this section.

In view of the relatively heavy treatment of the "doing" bird, Berger manages to include a surprising variety of other subject matter. Much of the material reflects the current literature, despite the fact that the treatment is, of necessity, frequently scanty. Thus, the section on migration (p. 123) explains proximate and ultimate factors but does not mention the refractory period. Despite (or because of?) the brevity in many cases, however, nonbiology majors may acquire an insight into a considerable amount of subject matter impinging upon, but not usually treated in, ornithology courses. In this connection, most of the references listed are cited in the text. Numerous experiments and reports mentioned throughout various chapters, however, are not included in the literature citations. The author rationalizes that most of this information is common knowledge to ornithologists and therefore that excessive documentation would merely be distracting in an elementary text. Nevertheless, he envisions the work as a possible ". . . source book for teachers in elementary and high schools and for parents of inquisitive

children," as well as a college text. It may well be, therefore, that some of his readers would benefit by knowing where to find such things as Yeatter's discussion of the possible effects of excessive air temperature on the southern distribution of Ring-necked Pheasants (p. 73), or Yeagley's paper on the postulated effects of the Coriolis force in bird navigation (p. 127).

The few errors of commission noted were mostly of small moment. *Pseudotsuga taxifolia* has been in synonomy for some time (p. 119). Kudzu has proved to be less than a blessing in the forestry-conscious southeast (Fig. 3, p. 313), and it came as a surprise to this reviewer to see the Galliformes categorically listed among the birds possessing a "penis" (pp. 190 and 301). One of the most delightful facets of the text is the author's candid and frequently iconoclastic exposé, ranging from the ostensible perspicacity of some ethologists (p. 133), through the diarrheic pens of some taxonomists (pp. 337 and 341). Furthermore, *Bird Study* assumes considerable stature through its emphasis on the "principle approach" to its subject. Biology has traditionally been taught as a cold, hard core of facts, to be memorized and then regurgitated when the proper string was pulled. It is patent that facts are necessary before thinking is possible, but the assimilation of facts all too frequently has been, and is, an end in itself. It is refreshing, therefore, to encounter an elementary text in which man's biological ignorance is not only admitted but glaringly delineated, and in which the reader's attention is directed toward some of the more spacious and hence significant questions that challenge our ingenuity. Berger notes the necessity of a teacher to go with a text in any good college course; granting the assumption, *Bird Study* could provide the basis for a good course in ornithology.—Ernest E. Provost.

Hummingbirds.—Crawford H. Greenewalt. 1960. Published for The American Museum of Natural History by Doubleday and Company, Inc., Garden City, New York. xiv + 250 pp., 69 color plates, 37 additional illustrations. $25.00.—This remarkable book is truly a unique contribution to ornithology. The color plates, which illustrate 59 species, constitute an almost unbelievable technologic and artistic attainment in high-speed color photography. Actually these plates defy description and must be seen to be appreciated. The accompanying text is excellently presented with numerous diagrams and drawings. The arrangement, design, and layout of the book give it a technical excellence that is rarely, if ever, excelled. The actual quality of the text is somewhat variable, perhaps the almost inevitable consequence of attempting to present relatively complex scientific material for the layman. There are excellent discussions of hummingbird colors and hummingbird flight, the latter placed in admirable perspective with animal flight in general. On the other hand anthropomorphisms are not infrequent, and there are instances in which emphasis on the spectacular has obscured or supplanted the possible rationalization of a phenomenon. It is readily apparent that these are devices intended to enhance popular communication, although I personally remain unconvinced that such are really necessary. Nevertheless, the text is generally very effective and provides a good resume of the general biology of the Trochilidae. Moreover, I must emphasize that, were there no text whatsoever, the plates alone would constitute a highly significant contribution to ornithology. The book will have a highly useful function in the library of any ornithologist; it will be a treasured item in the collection of most connoisseurs of good books.—D. S. Farner.

Dimensional Relationships for Flying Animals.—Crawford H. Greenewalt. 1960. Privately produced by the author, Greenville, Delaware. 7 pp., 17 graphs,

64 pp. of tabular data.—The author has gone to extensive effort to summarize in tables and graphs a vast quantity of data on animal flight and flying animals. The graphs relate (1) logarithm of wing length and logarithm of body weight for birds and insects, (2) logarithm of wing length and logarithm of body weight for hummingbirds alone, (3) logarithm of body weight and logarithm of wing area for insects and birds, (4) logarithm of body weight and logarithm of wing area for birds, (5) logarithm of wing area and logarithm of wing length for birds, (6) the same for insects, (7) the same for bats, (8) logarithm of wing length and logarithm of wing spread for birds, (9) logarithm of wing weight and logarithm of wing area for birds and insects, (10) logarithm of wing length and logarithm of rate of wing beat for birds and insects, (11) the same for hummingbirds alone, (12) the same for insects alone, (13) logarithm of body weight and logarithm of weight of pectoral muscles for birds, (14) logarithm of weight of large pectoral muscle and logarithm of wing weight for birds, (15) logarithm of weight of small pectoral muscle and logarithm of body weight for birds, (16) logarithm of weight of small pectoral muscle and logarithm of large pectoral muscle, (17) logarithm of total body weight and logarithm of muscle weight for insects. This compilation will be most useful to any serious student of the physiology or biology of flight. Serious students of this subject may obtain this compilation from the author's limited supply. It would be most useful if publication and a consequently wider distribution can be accomplished.—D. S. Farner.

The Romance of the Lyrebird.—Alec H. Chisholm. 1960. Angus and Robertson, Sydney, Australia. 156 pp. 16 pl. (1 col.). 1 map. 27s. 6d. (Aust.)—The Australian Lyrebirds *(Menura)*, large, primitive Passeres, resembling pheasants in appearance and in some of their habits, are ground inhabitants of the temperate and subtropical rain forests of the southeast of the continent. Their bizarre tail ornaments and extraordinary powers of vocal mimicry have long earned them more than ornithological renown. So it is amazing that a bird with so much potential biological interest should have been so neglected for serious study. Mr. Chisholm's book, a review of what is known about these birds, reveals partly why this is so—the difficult terrain, the usually secretive habits, long period of immaturity, and long life span of the birds, are all factors that militate against easy, short-term research projects. Curiously enough, the most useful summary of the ecology of these birds available to ornithologists until recently was in an American source, a review by Grace Sargent (in *News from the Bird-Banders*, 11 (3), 1936: 34) based on the field work of the Australian Tom Tregellas. Fortunately, local investigations on the biology of Lyrebirds are now in progress on an intensive scale, and we look forward to interesting results.

The value of the present volume is not so much for the novelty of the biological information it summarizes but for the accurate and highly exciting details of historical discoveries connected with the bird during the 19th and late 18th centuries. Mr. Chisholm is a competent archives researcher, and he has presented the results in his usual graphic style. Much of the early story, as hitherto known, had come down to us in garbled form. Chisholm relates the part played by governors, high colonial functionaries, convicts, and many other folk, in Australia and elsewhere, in uncovering the Lyrebirds' story. The accounts are fully documented, and there are numerous reproductions of early drawings and portraits of the characters in this entrancing ornithological drama.

The final chapter briefly discusses conservation problems. The two species survive in strength, and there is little to fear for their future. Lyrebirds nest in the

rough, sandstone country within a few miles of Sydney, and any tourist will have no difficulty in seeing the birds in the Sherbrooke Forest reserve near Melbourne. In the past, however, the outlook appeared grim. The southern bird (*M. superba*) was massacred for its spectacular tail plumes. They were displayed in bush inns and household parlors, and dealers and hawkers traded in them freely. As late as 1910 two Sydney dealers had traded the feathers of nearly 1,300 birds in a year. Times have completely changed, and to kill or harm a Lyrebird in Australia today would be unthinkable.—D. L. SERVENTY.

Birds of River Tama.—Sakae Tamura. 1961. Japan Trading Co., Ltd., Chiyada-ku, Tokyo, Japan. 177 pp. 300 photographs (four in color). Y3,500.—The Tama-gawa, so named for its clear water, has become excessively polluted by the rapid growth of Tokyo and Kawasaki. The curious but effective mixture of photographs depict well the effects of industrialization and overpopulation, and equally well the interesting bird life that manages to survive. Of particular interest are good series of photographs of the Japanese Long-billed Ringed Plover *(Charadrius placidus)*, the Snowy Plover *(Charadrius alexandrinus)*, the Little Ringed Plover *(Charadrius dubius)*, and the Asiatic Little Tern *(Sterna albifrons)*. This book is indeed a strong voice for enhanced conservation measures in Japan.—D. S. FARNER.

Die Vogelwelt des Südkaspischen Tieflandes.—Ernst Schüz. 1959. Schweizenbart, Stuttgart. 199 pp. DM 18.—The author spent the three spring months of 1956 on the coast of the Caspian Sea. The results of this expedition are worked into a thorough zoogeographic-faunistic monograph of the Caspian area of Persia. The geographic picture is illuminated by the excellent habitat photographs of the author and by numerous maps. The previous faunistic literature—from 1774 to date—is critically evaluated, and also treated in the annotated check-list, which forms the bulk of the publication. The zoogeographic analysis corroborates Stegmann's (1938) finding, *viz.*, that the avifauna has a strong European character. In a comparison with birds of West Europe only one fifth of the South Caspian species are missing, mainly of Mediterranean origin: over half of the fauna is represented by the same subspecies from France throughout Turkmenia; the arid plains of the latter, and the arid mountains that delimit the South-Caspian plains in the south had apparently engulfed and preserved this avifaunal outpost throughout the postglacial times. The recent climate is Mediterranean-subtropical, and local subspecies are generally darker. Many also show habitat peculiarities and songs or calls different from their west European counterparts, and these are summarized. A quite considerable chapter deals with bird migration, and here the great experience of the author, and his summarizing of the recent Soviet literature, resulted in a clear sketch of the role of wintering groups, transients, weather movements, guiding lines, etc. This is an important wintering area of southeast European and west Siberian waterfowl. Finally we learn from this fine book that oil pollution and hunting pressure on the coast, further habitat alterations and other human influences would necessitate immediate conservation measures to preserve the avifauna; especially the bigger birds, eagles, vultures, etc., so rare in the western part of their range, could and should be saved.—M. D. F. UDVARDY.

Seminaire sur l'Histophysiologie du Complexe hypothalamo-hypophysaire.—J. Benoit. 1961. Séminaires du Collège de France, Chaire d'Histophysiologie,

No. 1. 350 pp. (mimeographed).—The 24 papers in this seminar constitute useful reviews and present interesting new ideas concerning many aspects of the organization and function of the hypothalamo-hypophysial axis. The balance of the seminar is good with ample attention to nonmammalian vertebrates. This collection will be of particular value among ornithologists to those who are interested in the mechanisms by which such phenomena as molt, reproduction, and migration are controlled. A most useful contribution is that of A. Tixier-Vidal on the cytology of the adenohypophysis of birds (pp. 102-112), a subject that is indeed in need of critical study.—D. S. FARNER.

Ecology of the Aspen Parkland of Western Canada in Relation to Land Use.—R. D. Bird. 1961. Res. Branch Can. Dept. Agric., Ottawa, Public. 1066, 155 p.—This is a well-documented description of past vegetation and animal life upon which changes were induced by land-use practices of white man. General, nonstatistical descriptions of grassland, forest, and aquatic communities are given. The influence of Indian fires in restricting distribution of aspen forest is firmly established, but the evidence seems insufficient to conclude that bison and wapiti overutilized the arboreal vegetation to the point of limiting distribution. Aspen forests initially expanded over former grassland when white man controlled fires. The trend now is toward intensified agriculture, reduction in aspen forest, and simplification of communities through the use of pesticides. Valuable comments are provided on general changes in many populations of insects, birds, and mammals. The description of biotic changes provides a useful background for understanding present plant and animal life in the region considered.—H. K. BUECHNER.

Type Specimens of Birds in the United States National Museum.—Herbert G. Deignan. 1961. U.S. National Museum Bulletin 221. x + 718 pp. Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. $2.75.—The U.S. National Museum, having one of the major collections of birds, is also one of the major depositories of type specimens. Because of this, Dr. Deignan's painstaking list is an invaluable contribution to taxonomic ornithology.—D. S. FARNER.

Bird Songs in Your Garden.—Cornell University Records, Cornell University Press, Ithaca, New York. 24 pp., one vinylite record. $5.95.—A magnificent feast for eye and ear awaits those who acquire a copy of *Bird Songs in Your Garden*. This publication is in the form of a bookalbum, consisting of a loose-leaf, hard-back notebook containing some 24 pages of descriptive material and a pocketed, 10-inch disc recording. The text is concerned with 25 species whose songs are heard commonly in the gardens of eastern United States and Canada; it contains 53 handsome photographs, 31 in full color, from National Geographic Society reproductions. Included also are notes on plumage, planting to attract birds, building water and feeding stations, and homes, as well as a selected reading list for gardeners.

The recording occupies both sides of a flexible, vinylite, long-play disc at 33⅓ rpm. The reproduction is almost flawless on a good, high-fidelity, play-back system. Frequency range is excellent, and we have seldom heard such a low background noise level. The original recordings were made by Professor P. P. Kellogg and surely will add further luster to his high international reputation in this field.

As the album states, "The recording starts before dawn in an eastern garden with the awakening song of the Wood Pewee and ends after dark with the tremolo of the Screech Owl (who never screeches)." On Side One, the birds are briefly announced, whereas on Side Two, there are no announcements. Each bird virtually sings alone. We first hear him low in the background as he is announced and then more loudly and clearly as he sings his performance. There is never any question as to what bird is "on stage." It is this feature that makes this recording such an excellent study device for bird recognition. At the same time, the "on-stage" quality makes for a certain lack of naturalness, since the bird appears to have been removed from his setting.

A comment, which may or may not be valid, is that Side Two, wherein the birds sing unannounced, may have been improved by having the order of bird entrances differ from those on the announced side. In that way, the recording might serve better as both textbook and quiz.—E. W. GREENFIELD.

[Dr. Greenfield is an electrical engineer with long and varied experience in the recording and reproduction of sound. I asked him to prepare this review giving careful attention to the technical quality of the recording. Ed.]

An Annotated Bibliography on the Uses of Statistics in Ecology.—Vincent Schultz. 1961. Atomic Energy Commission, Office of Technical Information, TID-3908. 315 pp. $3.00.—The author has recorded and classified references to papers using statistics in ecology from a modest sample of 25 journals that are primarily ecological or that contain ecological papers. Also included are references from six statistical journals. Papers dealing with birds are included in the section on wildlife (pp. 1-63), which, like the other sections, has the references arranged by journals. The indices are arranged primarily from the aspect of statistics and uses thereof in the papers listed.—D. S. FARNER.

Ornithological Books in the Yale University Library Including the Library of William Robertson Coe.—S. Dillon Ripley and Lynett L. Scribner. 1961. Yale University Press, New Haven, Conn. vii + 338 pp.—Since the Yale University Library contains one of the largest collections of ornithological books in the country, the authors have rendered an important service to ornithology in preparing this list. Holdings in ornithological journals and biological journals that contain papers on birds are also listed, thus enhancing the value of the publication. Many of the entries include brief but useful annotations.—D. S. FARNER.

Ten-Year Index to the Auk, Volumes 58-67, 1941-1950.—Prepared by George Willett and Charles K. Nichols; edited by Charles K. Nichols. 1960. iv + 449 pp. $10.00 (bound); $8.00 (unbound).—Although the extensive and painstaking effort required to produce this volume was begun by the late George Willett, the vast bulk of the task remained for Charles K. Nichols. It should be emphasized that this index is by no means a simple compilation of the 10 annual indices. Mr. Nichols read and abstracted every article, note, review, and item of recent literature and then indexed each item that he considered of interest. Although working scientists use such indices repeatedly, few of us appreciate their enormous value and even fewer appreciate the effort and talent required in their preparation. The Union and ornithologists generally are deeply indebted to Mr. Nichols for this invaluable contribution.—D. S. FARNER.

The Bird Watcher's Guide.—Henry Hill Collins, Jr. 1961. Golden Press, 630 Fifth Avenue, New York. 125 pp. $3.95.—The primary function of this lavishly illustrated little book will be that of leading from a casual interest in birds to a hobby of bird watching or a serious study of ornithology. Particularly in the initial steps it should be very effective. It is packed with useful and condensed information. The compilation of such information has not been without errors. As examples, I find among "Food Preferences of Birds" that the Tree Swallow likes bayberries; the address of the editor of *Bird Banding* is incorrect; and curiously the German ornithological organizations have been omitted from the list of societies abroad. The sections dealing with equipment for bird watching, photographing birds, bird banding, and conservation are good if considered in light of the objectives of the book. All in all, it should be useful as an introduction to bird watching.—D. S. FARNER.

Style Manual for Biological Journals.—Prepared by the Committee on Form and Style of the Conference of Biological Editors, J. R. Porter, Chairman. Published for the Conference of Biological Editors by the American Institute of Biological Sciences, 2000 P Street, NW, Washington 6, D.C. xiii + 92 pp. $3.00.—This manual is the result of a concerted and well-conceived effort to effect a reasonable standardization of the preparation of manuscripts for biological journals. It is both comprehensive and succinct and should go far in easing the problems of preparation of manuscript by busy investigators in all fields of biology. The manual has been adopted, in whole or in part, by 78 journals, including *The Auk*.—D. S. FARNER.

RECENT LITERATURE

EDITED BY FRANK McKINNEY

Anatomy and Embryology

De Gennaro, L. D. 1959. Differentiation of the glycogen body of the chick embryo under normal and experimental conditions. Growth, **23**: 235–249.

Lindenmaier, P., and M. R. Kare. 1959. The taste end-organs of the chicken. Poultry Sci., **38**: 545–550.—Morphology, distribution, and numbers of taste buds.—P. H. B.

Wetherbee, D. K. 1961. Observations on the developmental conditions of neonatal birds. Amer. Midl. Nat., **65**: 413–435.—Data on a number of species (chiefly North American) artificially hatched in an incubator, giving *inter alia*, longest incubation period, average weight of egg and neonatal, average length of certain neonatal bones compared with adults.—E. E.

Behavior

Dane, B., C. Walcott, and W. H. Drury. 1959. The form and duration of the display actions of the Goldeneye *(Bucephala clangula)*. Behaviour, **14**: 265–281.—Analysis of movie films provides a detailed catalog of displays. Two categories are distinguished: (1) flock displays and (2) precopulatory actions and copulation. Some displays are very constant in form and duration; others have constant form but vary in duration. Some female displays are variable in both form and duration.—F. M.

Dilger, W. C. 1960. The comparative ethology of the African Parrot genus Agapornis. Zeitschr. für Tierpsychol., **17**: 649–685.—The behavior of all species of *Agapornis* except *swinderniana* (five species, including all four subspecies of *personata*) was studied in great detail under captive conditions. Behavior of the young, maintenance activities, locomotion, agonistic and reproductive behavior are fully described. Evolutionary trends in morphological and behavioral characters are traced, *e.g.*, loss of sexual dichromatism (with coincident changes in agonistic and sexual behavior), increasing ritualization of displacement scratching, gradual loss of carrying nest material in the feathers and the acquisition of carrying such material in the bill, increase in complexity of nests. It is suggested that "display extinction must be as normal as display evolution and . . . there must be very strong competition among existing displays from the standpoint of their value as signals prompting certain responses in the recipient." The paper is very fully illustrated with one color plate and a fine series of photographs.—F. M.

Drury, W. H., Jr. 1960. Breeding activities of Long-tailed Jaeger, Herring Gull and Arctic Tern on Bylot Island, Northwest Territories, Canada. Bird-Banding, **31**: 63–79.—Behavioral and life history observations of examples of three subgroups of Laridae are presented and compared.—R. E. P.

Frazier, A., and V. Nolan, Jr. 1959. Communal roosting by the Eastern Bluebird in winter. Bird-Banding, **30**: 219–226.

Hall, K. R. L. 1960. Egg-covering by the White-fronted Sandplover *Charadrius marginatus*. Ibis, **102**: 545–553.—The author made 118 daylight observations on the degree to which this plover covered its eggs with sand at 41 different nests. In 44 per cent of the observations the eggs were more than half covered,

and in only 23 per cent were they uncovered. Eggs were better covered between 0700 and 1500 suntime; at certain nests, eggs were more covered on second inspection than on first, in the same day. On 16 of 118 occasions when birds were frightened from the nest by a human, they made a leaving scuffle, which swept sand over the eggs. Similar behavior in other members of the genus is compared. The leaving scuffle indicates conflict of drives to incubate and escape. —J. W. H.

Johnsgard, P. 1960. Pair-formation mechanisms in *Anas* (Anatidae) and related genera. Ibis, **102:** 616–618.—The importance of "Leading-and-inciting" in pair formation is stressed. This behavior pattern and "Mock-preening" occur in most members of the genus *Anas* and are recorded in other tribes of Anatidae. —J. W. H.

Kear, J. 1960. Abnormal sexual behavior of a Hawfinch *Coccothraustes coccothraustes*. Ibis, **102:** 614–616.—A hand-raised female displayed to her brother but later transferred attention to the author, performing displays toward her and threatening other humans.—J. W. H.

Klopfer, P. H. 1959. Social interactions in discrimination learning with special reference to feeding behavior in birds. Behaviour, **14:** 282–299.—Feeding tests with Greenfinches showed that single birds learned to discriminate between two patterns rapidly as did birds allowed to observe a trained bird performing. Birds trained in the presence of an untrained partner required much longer. In this case, it appears that a feeding response can be established more easily than an avoidance response by a process of conditioning. This type of learning is thought to operate in species with conservative feeding habits.—F. M.

Moynihan, M. 1959. Notes on the behavior of some North American Gulls. IV. The ontogeny of hostile behavior and display patterns. Behaviour, **14:** 214–239.—The development of displays in young Franklin's Gulls *(Larus pipixcan)* and Ring-billed Gulls *(L. delawarensis)* is described. All display calls are considered to develop from the two intensities of distress notes given by newly hatched chicks. Most display postures are variable at first and have no signal function; they gradually become standardized as this function develops.—F. M.

Murton, R. K. 1960. Some photographs of Wood Pigeon behaviour and feeding. Brit. Birds, **53:** 321–324.

Parmelee, D. F. 1959. The breeding behavior of the Painted Bunting in southern Oklahoma. Bird-Banding, **30:** 1–18.—Life-history study of the species in Oklahoma with particular attention to the role of the sexes in care of the young: only females built, incubated, or attended the brood, except that males cared for broods if females laid a second clutch. Behavior is compared to that of Indigo Buntings.—R. E. P.

Stokes, A. W. 1960. Nest-site selection and courtship behaviour of the Blue Tit *Parus caeruleus*. Ibis, **102:** 507–519.—Courtship behavior from nest selection to incubation is described, and the causation and origin of the behavior is discussed. Hole inspection maintains the pair bond. The courtship dance has been modified from the head-forward threat. The female dominates her mate when the nest site is selected. Great Tits dominate Blue Tits during site selection and may eject them. The Blue Tit's bright plumage may have evolved as enhancement of the head-forward threat and is of secondary epigamic value—J. W. H.

Tinbergen, N. 1959. Comparative studies of the behaviour of Gulls (Laridae): a progress report. Behaviour, **15:** 1–70.—An important paper summarizing much of the recent research on gull behavior and discussing broad conclusions that

are emerging from work on many species. The three central problems—functions, causation, and evolution of behavior patterns—are fully discussed. A functional distinction is made between "distance-increasing" and "distance-reducing" displays. Causation is discussed in terms of multiple motivation (the simultaneous arousal of attack, escape, and sexual "tendencies"). The performance of many displacement activities is thought to be facilitated by the primary occurrence of an intention movement. Evolutionary changes in displays and in behavior mechanisms and the ultimate causes for these are discussed.—F. M.

Warren, R. P. and R. A. Hinde. 1961. Does the male stimulate oestrogen secretion in female canaries? Science, **133**: 1354–1355.—Previous experiments had suggested that presence of the male accelerates (but does not initiate) estrogen secretion in female canaries, leading to nest-building. The present experiment indicates that females treated with estrogen will build nests during the non-breeding season, with or without the presence of males, and regardless of day-length or temperature. Ovulation did not occur (being suppressed by the exogenous estrogen), but incubation did, indicating that neither ovulation nor the presence of eggs or egg-substitutes is a prerequisite for incubating activity.—K. C. P.

Distribution and Annotated Lists

Benson, C. W. 1960. The birds of the Comoro Islands: results of the British Ornithologists' Union Centenary Expedition 1958. Ibis, **103b**: 5–106.—The Comoros consist of four main islands, of volcanic origin, situated at the northern end of the Mozambique Channel, between Africa and Madagascar. Until the present expedition, the avifauna was poorly known and no precise information was available on ecology. Breeding seasons are similar to those in Rhodesia, Nyasaland, and Madagascar. The avifauna is considered to be derived mostly from Madagascar (30 species) and Africa (12 species). The systematic list includes data on sub-species (12 new forms distinguished), distribution, ecology, and breeding condition of specimens collected. An appendix lists species now rejected or of uncertain occurrence and those introduced and now extinct.—F. M.

Dunmire, W. W. 1961. Birds of the national parks in Hawaii. Hawaii Nat. Hist. Assoc., Honolulu, Hawaii. 36 pp.—A most attractive booklet, well illustrated with line drawings, photographs, and a color plate, giving descriptions and notes on habitat, voice, status, and other matters. Areas treated: Hawaii Volcanoes National Park on the island of Hawaii and Haleakala National Park on Maui.—E. E.

Gallagher, M. D. 1960. Bird notes from Christmas Island, Pacific Ocean. Ibis, **102**: 489–502.—Includes a description of the island, table of rainfall, discussion of predators, and an annotated systematic list (with notes on 27 species) based on observations from June 1958 until June 1959. Breeding seasons vary greatly among species.—J. W. H.

James, D. 1960. Some recent findings concerning the avifauna of Arkansas. Proc. Ark. Acad. Sci., **14**: 8–13.

Mountfort, G. 1960. Notes on the birds of Tenerife. Ibis, **102**: 618–619.—Further documentation of the effects of human disturbance on the avifauna of this island. Several species reported as scarce in 1953 could not be found in 1960.—J. W. H.

Paige, J. P. 1960. Bird notes from Aden and Oman. Ibis, **102**: 520–525. The author's notes are intended to supplement Meinertzhagen's 1954 *Birds of Arabia*.

An annotated list of species includes notes on range extensions, migrations, and a brief discussion of feeding methods of *Pelecanus rufescens*.—J. W. H.

Shaub, M. S. 1959. Evening Grosbeak juvenals at Hadley, Massachusetts—July 1958. Bird-Banding, **30**: 226–228.

Smith, M. Q. 1960. Notes on the birds of the Trebizond area of Turkey. Ibis, **102**: 576–583.—Based on casual observations in 1958 and 1959 and on notes made by K. M. Guichard in 1959, the writer gives a description of the region, discusses migration, and provides a briefly annotated list of the birds observed.—J. W. H.

Stager, K. E. "1960" [-1961]. The composition and origin of the avifauna. *In* Symposium: The biogeography of Baja California and adjacent seas. Syst. Zool., **9**: 179–183.—Summary based largely on the work of J. Davis, also Grinnell and Nelson. The endemism of the Cape region does not represent a "potent center of differentiation," but a little-differentiated remnant of an avifauna associated with a Cape relict of a Sierra Madrean element of the Madro-Tertiary flora once continuously distributed to the north and east. The possibility of a direct land connection between the Cape and the Mexican mainland is rejected.—K. C. P.

Stager, K. E. 1961. The Machris Brazilian Expedition. Ornithology: Nonpasserines. Los Angeles Co. Mus. Contr. Sci., **41**: 1-27.—Birds collected in central Goiás, Brazil, in 1956; habitat and abundance indicated.—E. E.

Tickell, W. L. N. 1960. Notes from the South Orkneys and South Georgia. Ibis, **102**: 612–614.

Udvardy, M. D. F. 1961. Additions to the check list of Hawaiian birds. Elepaio, **21**: 84–90.—Additions to the 1958 check-list of E. H. Bryan, Jr., as well as cases of changed status or new records of supposedly rare birds, documented by literature references, usually of sight observations.—E. E.

Webb, J. S., and D. K. Wetherbee. 1960. Southeastern breeding range of the Brown-headed Cowbird. Bird-Banding, **31**: 83–87.—Evidence for a recent southern extension of the breeding range of this species.—R. E. P.

Ecology and Populations

Ash, J. S. 1960. Bird of prey numbers on a Hampshire game-preserve during 1952-1959. Brit. Birds, **53**: 285–300.

Atkinson-Willes, G. L., and G. V. T. Matthews. 1960. The past status of the Brent Goose. Brit. Birds, **53**: 352–357.

Norris, R. A. 1960. Density, racial composition, sociality, and selective predation in nonbreeding populations of Savannah Sparrows. Bird-Banding, **31**: 173–216.—A detailed study of populations, behavior, predation, and ecology of both natural and "semi-confined" wing-clipped birds. Some signs of a social hierarchy were noted, and data suggesting differential predation among races are presented.—R. E. P.

Sowls, L. K. 1960. Results of a banding study of Gambel's quail in southern Arizona. J. Wildl. Mgt., **24**: 185–190.—Recovery data suggest that birds which hatch in a year of high productivity continue to have a higher survival rate, even as adults in later years, than birds hatched in a year of low productivity.

Stamm, D. D., D. E. Davis, and C. S. Robbins. 1960. A method of studying wild bird populations by mist-netting and banding. Bird-Banding, **31**: 115–130.—A comparison of mist netting and recapture of banded birds with the spot-

mapping technique for estimating breeding bird populations, both approaches being used simultaneously on the same area. The method allows detection and evaluation of error resulting from net shyness and recruiting, and further allows collection of data on disease and parasites. The two census techniques gave close agreement.—R. E. P.

Yocom, C. F., and H. A. Hansen. 1960. Population studies of waterfowl in eastern Washington. J. Wildl. Mgt., **24**: 237–250.—Distribution and production of ducks and factors affecting them, particularly weather.—J. P. R.

Evolution and Genetics

Hamilton, T. H. 1961. The adaptive significance of intraspecific trends of variation in wing length and body size among bird species. Evolution, **15**: 180–195.—A review of ecogeographical "rules" affecting size variation in birds, with emphasis on the multiplicity of possible selection forces involved. Should be read in connection with Rand's criticism (*Wils. Bull.*, **73**, 1961: 46–56) of an earlier paper by Hamilton, and the latter's reply (*ibid.*: 215–217).—K. C. P.

Irwin, M. R., and W. J. Miller. 1961. Interrelationships and evolutionary patterns of cellular antigens in Columbidae. Evolution, **15**: 30–43.—Analysis of the presence or absence in over 30 species of Columbidae of cellular antigens that distinguish *Columba livia* and *C. guinea* from one another. "Undoubtedly the relationships of the cellular antigens in these various species are an index of changes in the causative genes, so that the relationships among the cellular antigens are indicative of the changes from a common ancestral form which have occurred in the evolution of these species" (from authors' summary).—K. C. P.

Lowther, J. K. 1961. Polymorphism in the White-throated Sparrow, *Zonotrichia albicollis* (Gmelin). Can. J. Zool., **39**: 281–292.—Examination of 286 museum and 199 live specimens revealed two morphic types in both sexes (white-striped and tan-striped, according to the color of the median crown stripe). Proportions of white-striped males and tan-striped females increased from Newfoundland to the northwestern part of the range. The morphic types appear to be genetically determined and do not change with age. White-striped morphs mate selectively with tan-striped morphs; this appears to be the only case of this type of selective mating known in birds. Evidence that the proportion of the two forms in the central part of the range has not changed over a period of 100 years suggests that this species exhibits a balanced polymorphism.—F. M.

Mayfield, H. 1961. Cowbird parasitism and the population of the Kirtland's Warbler. Evolution, **15**: 174–179.—Essentially a summary of Chapter 14 of Mayfield's book (1960. *The Kirtland's Warbler*. Cranbrook Inst. Sci.), with emphasis on the impact of cowbird parasitism on survival of the warbler as a species.—K. C. P.

Newcomer, E. H. 1959. The meiotic chromosome of the fowl. Cytologia, **24**: 403–410.—On the removal of microchromosomes from a chromosomal status to that of chromosomoids.—P. H. B.

Sato, I., and I. L. Kosin. 1960. A cytological study of the parthenogenetically developing turkey germ discs and embryos. Cytologia, **25**: 256–266.—Lists evidence that macrochromosomes and microchromosomes are of the same nature, contra Newcomer.—P. H. B.

GENERAL BIOLOGY

Carvalho, C. T. de. 1960. Sôbre pterilose e bionomia de *"Panyptila cayennensis"* (Gmelin, 1789) (Aves, Apodidae). Rev. Brasil Biol., **20** (3): 315–325.—Notes on the biology and pterylosis of the Lesser Swallow-tailed Swift in Belem, Pará, Brazil. Birds use the nest for roosting and shelter throughout the year and probably have two broods. (In Portuguese; English summary.)—E. E.

Carvalho, C. T. de. 1960. Comportamento de *Myiozetetes cayanensis* e notas biológicas sobre espécies afins (Passeres, Tyrannidae). Pap. Avul. Dept. Zool., S. Paulo, **14** (15): 121–132.—Data on the life history, including incubation period, of a tropical tyrannid in Brazil, with comparative notes on certain allied species. States that in addition to the well-known spherical nest, *Pitangus sulphuratus* also builds open cup nests in sheltered situations. (In Portuguese; English summary.)—E. E.

Davis, T. A. W. 1960. Kestrel pellets at a winter roost. Brit. Birds, **53**: 281–284.

Davison, V. E., and W. H. Hamor. 1960. A system for classifying plant foods of birds. J. Wildl. Mgt. **24**: 307–313.—Foods are classified as choice, fair, and unimportant. Stomach analysis, observation, experiment, and field trial are all needed to understand food habits of a species.—J. P. R.

Lloyd, M. 1960. Statistical analysis of Marchant's data on breeding success and clutch-size. Ibis, **102**: 600–611.—An astute application of statistical analysis to Marchant's breeding data on Ecuadorian birds published in recent issues of *Ibis*. Some year-to-year changes in breeding success are most likely correlated with changes in abundance of snakes, not, as supposed by Marchant, with certain differences in weather. Lloyd reveals the existence of a mechanism for clutch-size adjustment for species that nest in both the growing and dry seasons and presents evidence that clutch size may be affected by unfavorable weather in midbreeding season (or by abundance of snakes then or some other unrecognized factor). There are included several pages of commentary by Mr. Marchant.—J. W. H.

Marchant, S. 1960. The breeding of some S. W. Ecuadorian birds. Ibis, **102**: 584–599.—A continuation of the author's studies published in previous numbers of the *Ibis*. Specific accounts deal with many aspects of breeding in *Molothrus bonariensis, Icterus grace-annae, Pezites militaris, Pheucticus chrysopeplus, Neorhynchus peruvianus, Sporophila telasco, Volatinia jacarina, Phrygilus alaudinus, Rhodospingus cruentus,* and *Poospiza hispaniolensis*. These studies provide valuable and often unique contributions to our knowledge of South American birds.—J. W. H.

Mussehl, T. W. 1960. Blue grouse production, movements, and populations in the Bridger Mountains, Montana. J. Wildl. Mgt. **24**: 60–68.—Chronology and extent of seasonal movements, development of young, population characteristics, and general life-history information.—J. P. R.

Seel, D. C. 1960. The behaviour of a pair of House Sparrows while rearing young. Brit. Birds, **53**: 303–310.

Snow, B. 1960. The breeding biology of the Shag *Phalacrocorax aristotelis* on the island of Lundy, Bristol Channel. Ibis, **102**: 554–575.—A comprehensive study from May 1954 to May 1958 provided statistics on breeding season, nest sites and nests, egg laying, replacement clutches, clutch size, incubation and hatching success, egg size and weight, fledgling success, weight of the young and period of dependence on parents, and variation in breeding success.—J. W. H.

Williams, G. R. 1959. Aging, growth-rate and breeding season phenology of wild populations of California Quail in New Zealand. Bird-Banding, **30**: 203–218.—Development of the primaries was used for aging and found to give hatching date within three-four days for the ages 4-21 weeks in the field. A difference in rate of increase of body weight between wild and captive young was consistent but small. Data indicate a five-month breeding season, peaking in December.—R. E. P.

MANAGEMENT AND CONSERVATION

Atwood, E. L., and A. D. Geis. 1960. Problems associated with practices that increase the reported recoveries of waterfowl bands. J. Wildl. Mgt. **24**: 272–279.—Variability in reported recoveries for different years, areas, and species is increased by efforts to get a higher proportion of shot, banded ducks reported.—J. P. R.

Campbell, H. 1960. An evaluation of gallinaceous guzzlers for quail in New Mexico. J. Wildl. Mgt. **24**: 21–26.—Providing surface water for quail is considered impractical under New Mexico conditions, in view of the high cost and doubtful value of "guzzlers."—J. P. R.

Carney, S. M., and A. D. Geis. 1960. Mallard age and sex determination from wings. J. Wildl. Mgt. **24**: 372–381.—Wings collected from hunters were classified with better than 95 per cent accuracy. The use of such information in measuring populations and hunting mortality is discussed.—J. P. R.

Cohen, A., H. S. Peters, and L. E. Foote. 1960. Calling behavior of Mourning Doves in two midwest life zones. J. Wildl. Mgt. **24**: 203–212.—A statistical study of aspects of calling behavior potentially useful in censusing.—J. P. R.

Diem, K. L., and K. H. Lu. 1960. Factors influencing waterfowl censuses in the parklands, Alberta, Canada. J. Wildl. Mgt. **24**: 113–133.—Species characteristics and behavior, seasonal vegetative development, human error, time of day, and weather conditions as they affect aerial, roadside, and ground beat-out censuses—J. P. R.

Geis, A. D., and E. L. Atwood. 1961. Proportion of recovered waterfowl bands reported. J. Wildl. Mgt. **25**: 154–159.—About two banded birds are shot for each one reported. Conservation employees affect the proportion by reporting bands for hunters.—J. P. R.

Hanson, W. R., and R. J. Miller. 1961. Edge types and abundance of bobwhites in southern Illinois. J. Wildl. Mgt. **25**: 71–76.—The amount of certain edge types is more important than the aggregate of all edge types. Number of different cover tracts per unit area is also important.—J. P. R.

Hickey, J. J., and L. B. Hunt. 1960. Initial songbird mortality following a dutch elm disease control program. J. Wildl. Mgt. **24**: 259–265.—Robin mortality of 86-88 per cent began 7-15 days following spraying during the tree-dormant season, but generally lagged behind spraying by three weeks. Transient birds in May were not noticeably affected.—J. P. R.

Hunt, L. B. 1960. Song bird breeding populations in DDT-sprayed dutch elm disease communities. J. Wildl. Mgt. **24**: 139–146.—Study plots in three unsprayed communities averaged 409 breeding pairs per 100 acres. Plots in three sprayed communities contained 31, 68, and 90 per cent fewer breeding pairs.—J. P. R.

Korschgen, L. J. 1960. Production of game bird foods in Missouri. J. Wildl. Mgt. **24**: 395–401.—Good seeds of important fall foods were sufficiently abundant to support a higher quail population than was present.—J. P. R.

MIGRATION, ORIENTATION, AND BANDING

Baird, J., A. M. Bagg, I. C. T. Nisbet, and C. S. Robbins. 1959. Operation recovery—report on mist-netting along the Atlantic Coast in 1958. Bird-Banding, **30**: 143–171.—Report of cooperative efforts of 18 banding stations along the coast and a comparison with the previous year. Data from a large number of netting stations working simultaneously indicate that all large waves occurred closely after passage of cold fronts and usually with a sharp temperature drop and a flow of polar air. Cloud and rain delayed several waves. Waves of Yellow-breasted Chats usually arrived on SW winds and it is suggested that they come from the southwest, apparently coinciding with the arrival of many other southern and western birds in the Northeast.—R. E. P.

Baird, J., and I. C. T. Nisbet. 1959. Observations of diurnal migration in the Narragansett Bay area of Rhode Island, in fall 1958. Bird-Banding, **30**: 171–181.—Observations indicating species differences in willingness to cross open water, even between species of swallows, and describing local movement patterns.—R. E. P.

Berger, D. D., and H. C. Mueller. 1959. The Bal-Chatri: a trap for the birds of prey. Bird-Banding, **30**: 18–26.—Description of construction and use of a modification of this trap.—R. E. P.

Davis, D. E. 1960. Comments on the migration of Starlings in eastern United States. Bird-Banding, **31**: 216–219.—Interpretation of banding data to indicate some Starlings are migratory, some sedentary in U.S.—R. E. P.

Harris, S. W. 1961. Migrational homing in Mourning Doves. J. Wildl. Mgt. **25**: 61–65.—Adults had a calculated homing rate of nearly 100 per cent for males and 60 per cent for females. The rate for doves banded as nestlings was only 2 per cent—J. P. R.

Hofslund, P. B. 1959. Fall migration of Herring Gulls from Knife Island, Minnesota. Bird-Banding, **30**: 104–114.—Eighty-one band returns show a tendency for first-year birds to wander more than adults and for them to go east along Lake Superior. (See also Smith, W. J., *Bird-Banding*, **30**: 69–104.)—R. E. P.

Lack, D. 1960. Autumn "drift-migration" on the English east coast. Brit. Birds, **53**: 325–352, 379–397.—A detailed analysis of arrivals of night-migrant chats, warblers and flycatchers at observatories on the east coast, from 20 August to 10 October 1949-1959. The theory of Williamson and other workers that these migrants reach England as a result of "down-wind directed drift" is criticized. It is shown that there is a passage of night migrants in the absence of westward drift. Although the number of arrivals does tend to be large with easterly winds, this is only partly caused by drift, since easterly winds are associated with anticyclones over southern Scandinavia and these conditions favor heavy departures. Weather conditions (often local) on the English coast affect the proportion of migrants alighting.—F. M.

Middleton, R. J. 1960. Banding Robins at Norristown. Bird-Banding, **31**: 136–139.

Sargent, T. D. 1959. Winter studies on the Tree Sparrow, *Spizella arborea*. Bird-Banding, **30**: 27–37.—A study of flock structure and movements of Tree Sparrows in winter, suggesting that no structure exists and that the birds do not remain in a particular wintering area but wander.—R. E. P.

Shaub, M. S. 1960. The Evening Grosbeak incursion in the Northeast winter of 1957-1958. Bird-Banding, **31**: 140–150.

Shaub, B. M. 1960. The destruction of nearly one hundred Evening Grosbeaks at St. Leon le Grand, Quebec. Bird-Banding, **31**: 150–156.

Sheldon, W. G. 1960. A method of mist netting Woodcocks in summer. Bird-Banding, **31**: 130–135.

Sladen, W. J. L., and R. L. Penney. 1960. Penguin flipper-bands used by the USARP bird-banding program 1958-60. Bird-Banding, **31**: 79–82.

Smith, K. D. 1960. The passage of palaearctic migrants through Eritrea. Ibis, **102**: 536–544.—Status and altitudinal range of migrants and winter visitors is given. The paper supplements the author's (1957) check-list of the area. Rarities and species of uncertain status as well as coastal passage of ducks, waders, and sea birds are omitted.—J. W. H.

Smith, W. J. 1959. Movements of Michigan Herring Gulls. Bird-Banding, **30**: 69–104.—An analysis of 1,143 recoveries from bandings of nestlings on island colonies in Lakes Huron and Michigan. Young birds wandered more than adults and tended to follow water courses. A marked eastward tendency in autumn is tentatively explained by drift with the prevailing winds while soaring. —R. E. P.

Williamson, K., and I. J. Ferguson-Lees. 1960. Nearctic birds in Great Britain and Ireland in autumn 1958. Brit. Birds, **53**: 369–378.—Summarizes the unusually large number of records (involving 17 species) and relates their occurrence to North Atlantic weather conditions.—F. M.

Woodford, D. 1959. The use of mist-nets and a Heligoland trap at Point Pelee. Bird-Banding, **30**: 38–46.—A comparison of the effectiveness of the two types of trap, including data from many hours of trapping both ways.—R. E. P.

Physiology

Helms, C. W., and W. H. Drury, Jr. 1960. Winter and migratory weight and fat field studies on some North American Buntings. Bird-Banding, **31**: 1–40.—Weight and fat studies of Tree Sparrows and Slate-colored Juncos and their relations to flocking, weather, and migration. About half of the daily variations of about 10 per cent of mean body weight were attributed to fat changes, the rest to ingested food. Variation was greatest in midwinter for both species. A scheme is given for classifying fat levels in trapped, living birds. Both species gained weight in midwinter and lost it after. Winter weight changes were closely related to temperature changes, but became independent of temperature during migratory periods.—R. E. P.

Vinogradov, I. N. 1960. The aerodynamics of soaring bird flight. (Aerodinamika ptits-paritelei. DOSARM, Moscow. 1951.) Translator B. Toms. Roy. Aircraft Estab., Ministry of Aviation, London, England. Library Transl., No. **864**: 1–75.—Translation of a Russian work, published in 1951, which discusses certain aspects of bird flight (providing some mathematical formulae), with a view to application in building flapping flight aircraft. Through their complex wing and feather structure birds combine thrust with stability and maneuverability in a more efficient manner than do fixed-wing aircraft. Birds achieve boundary layer control, it is suggested, by blowing the air away through their wing slots, by sucking it away into the filamentous padding of wing down, and by creating circulation independent of the angle of attack, in trembling and hovering flight, by vibrating the manus. The corrugated wing surface and the wing down serve as "an adaptive disturbance of the flow properties of the wing." The V-forma-

tion adopted by many large, gregarious birds in flapping flight provides, the author urges, a wavelike flow of air, the energy of which is utilized by the following birds.—E. E.

Taxonomy and Palaeontology

Goodwin, D. 1960. Taxonomy of the genus *Ducula*. Ibis, **102**: 526–535. A revision of the columbid genus *Ducula* of the Australasian and oriental regions, together with a discussion of affinities of related genera. "The genus *Ducula* is very close to *Ptilinopus*, *D. poliocephala* and its allies forming a connecting link between the two genera. The pied imperial pigeons are the most discrete group within *Ducula*." *D. paulina* and *D. oenothorax* are termed races of *D. aena*. *Lopholaimus* and *Hemiphaga* are considered closer to each other than either is to *Ducula* and are retained as monotypic genera. *Drepanoptila* and *Alectroenas* have evolved from *Ptilinopus* stock.—J. W. H.

Hall, B. P. 1961. The taxonomy and identification of pipits (genus *Anthus*). Bull. Brit. Mus. (Nat. Hist.) Zool., **7**(5): 247–289.—All species are treated, but the Palearctic forms in much greater detail, including data on molts.—E. E.

Irwin, M. P. S. 1960. The relationship of some aberrant African *Serinus*. Ibis, **102**: 503–506.—Eleven specimens of *Serinus* collected in Portuguese East Africa adjacent to the Sabi-Lundi River junction in Southern Rhodesia provide "a range of variation from near *S. atrogularis* to near *S. mozambicus*." The systematic relationships of these two species, the generic affinities of the former, the ecological and geographical characteristics of their distribution, and similar problems among other species of *Serinus* are discussed. The aberrant specimens indicate local breakdown of isolating mechanisms (with resultant secondary hybridization) or reversion to ancestral characters.—J. W. H.

Tilden, J. W. 1961. Certain comments on the subspecies problem. Syst. Zool., **10**: 17–23.—An attempt at analyzing sources of disagreement on the value of the subspecies concept. "The good results outweigh the objections that have been brought forward." Most examples are taken from Lepidoptera; Tilden's unfamiliarity with ornithology is suggested by his use of "less than five thousand" as the total recognized number of bird species.—K. C. P.

Miscellaneous

Boswall, J. 1961. A world catalogue of gramophone records of bird voice. Bio-Acoustics Bull., **1** (2): 1–12. Cornell Univ. Lab. Ornith.—A useful list of commercially published records issued between 1910-1960. The list is by authors, giving title, diameter of the disk, rpm, publisher, and usually the number of species included. An introduction indicates the countries and zoogeographic regions in which published bird recordings have been made, and the total species (approximately 963) covered. Unfortunately there is no geographic cross referencing, and in a few instances neither the title of the disk nor the comment in this catalogue indicates the country or area whose birds are included.—E. E.

Eklund, C. R. 1959. Antarctic ornithological studies during the IGY. Bird-Banding, **30**: 114–118.—A survey of studies undertaken.

Wood-Gush, D. G. M. 1959. A history of the domestic chicken from antiquity to the 19th century. Poultry Sci., **38**: 321–326.

NOTES AND NEWS

The personal library of the late Dr. Frederick C. Lincoln, a Life Fellow of the American Ornithologists' Union, has been presented to the University of Colorado Libraries. The collection consists of nearly 400 books, more than 200 bound volumes of journals, and numerous pamphlets and reprints.

The Museum of Comparative Zoology, Harvard University, has just reprinted Volume III of the late J. L. Peters' *Check-list of Birds of the World.* This volume, long out of print, lists the Columbidae and Psittacidae and related families. It is available from the Museum at a cost of $10.00.

The only other volumes available are V ($7.00), VII ($6.00), and IX ($7.50), but if sufficient interest is indicated, the Museum hopes to reprint additional volumes. Of the unpublished volumes, XV, containing the Ploceidae, Sturnidae, Oriolidae, Dicruridae, Paradisaeidae, Corvidae, etc., is in press and should be available early in 1962. The proposed sequence for the remaining volumes is: X, XII, XIV, XIII, XI, and VIII.

Orders may be placed with and checks should be made payable to: Museum of Comparative Zoology.

The *Ten-Year Index to The Auk,* Volumes 58-67 (1941-1950), is now available at a cost of $8.00 per unbound copy and $10.00 per bound copy. Orders should be placed with The Treasurer, A.O.U., Fernow Hall, Cornell University, Ithaca, New York.

The University of California has established the Deep Canyon Desert Research Area at the western edge of the Colorado Desert near Palm Springs, California. The 10,000-acre preserve is located approximately 75 miles from the Riverside campus of the University, at the base of the Santa Rosa-San Jacinto Mountains. The area will provide wild land where biologists can make continued studies of native desert plants and animals in an undisturbed environment.

Style Manual for Biological Journals, prepared by the Committee on Form and Style of the Conference of Biological Editors, is now available. The *Manual* is priced at $3.00 and may be ordered from American Institute of Biological Sciences, 2000 P Street, N.W., Washington 6, D.C. Seventy-eight biological journals have adopted the *Manual* as a guide. *The Auk* will, in great part, follow the recommendations of the *Manual,* and authors are requested to consult the *Manual* in preparing their manuscripts for submission.

CORRESPONDENCE

Sir:

The confusing leading article of the 1961 *Auk* calls for comment. Despite his title, "Evolutionary Relationships among the North American Mallards," the author discusses primarily geographic distributions, population sizes, egg-white proteins(!), and certain behavioral patterns. Maps are based on ". . . the literature, personal communications, and the major United States collections," ". . . and from additional sight and specimen records available to me"; yet only two museums other than Cornell University are mentioned in the acknowledgments. These maps show many records of *platyrhynchos* far to the south; sometimes (Figure 1) the reader must search hard for any hint that these are not breeding localities. The section "Estimation of Gene Pools and Hybridization Incidence" discusses only a part of the area of present overlap of breeding *Anas p. platyrhynchos* and *rubripes;* these population estimates are worthless from most standpoints, since all were made in fall and winter, thus consisting of birds from very diverse areas, some of them outside of the zone of overlap. The section "Materials and Methods" tells us neither the source of the specimens examined nor what measures, if any, were taken to assure the purity of their strain. Instead, we read a long account of the measurement of general plumage darkness, a matter never considered of primary importance in this group by taxonomists. As was therefore predictable, this proves to have little real value. The taxonomically useful characters are mentioned by Johnsgard only in summarizing the literature, after which he ignores all of them except the secondary coverts! He merely states that ". . . supposed differences in speculum coloration . . . and the degree of streaking on the throat . . . were not considered of major importance for study."

Under "Evolutionary Implications" we read that sexually nondimorphic populations arose by the same mutation at three different times and places; whereas actually a consideration of the *entire* mallard group, including the Pacific island forms, points strongly in the *opposite* direction, *i.e.*, the acquiring once in a nondimorphic species of sexual dimorphism, a character that is still spreading out geographically.

The only original taxonomic comments in this lengthy article are: "The later description of the Mottled Duck . . . weakened these distinctions and left no clear-cut difference between these forms [*fulvigula* and *maculosa*] and the Black Duck"; "None of the described plumage or soft-part characters, aside from the sexual dimorphism of *platyrhynchos*, were found to be of absolute diagnostic value in differentiating any population from all other populations"; and "The described plumage differences . . . are scarcely valid characters on which to base species judgments." (Voice, plumage sequences, nests and eggs, and juvenal plumages are not even mentioned.) The conclusion therefore comes as rather a surprise: "I am in firm agreement with Delacour (1956) that *diazi* and *fulvigula* should be considered subspecies of *Anas platyrhynchos*," whereas "An accurate and completely satisfactory disposition of *rubripes* cannot, in my opinion, be made. No modern taxonomist has as yet formally proposed the conspecificity of *rubripes* and *platyrhynchos*," though Baillie suggested this and Trautman calls them "not 'good' species."

As a matter of fact, in a symposium on speciation in 1957 (*J. Ariz. Acad. Sci.*, 1 (1), 1959), I pointed out the Mallard-Black Duck group as an example of the famous "open-ring form," and pointed out how failure to recognize this had led

to erroneous records of northward straying by *diazi novimexicana* and *fulvigula maculosa,* by those who refuse to recognize open-ring forms in North America. Since this new journal may not be available to some readers, I quote excerpts: "Female and eclipse plumages, voice, and ecology, at least, are very similar throughout the group. The main morphological gap is in New Mexico, where the familiar green-headed Mallard drake becomes a hen-feathered male *(diazi)* much like a female Mallard. There is little or no good evidence of reproductive isolation in the Albuquerque region and northward, where a careful study is needed; breeding experiments should also be conducted to expose the genetic basis. Farther southeast and east we have *maculosa,* north of which nests the Black Duck, *ribripes,* partially overlapping the breeding range of *A. p. platyrhynchos,* with only limited hybridization. . . . Differences between this case and the famous one of the Herring and Lesser Black-backed Gulls *(Larus argentatus)* are: (1) the step from *platyrhynchos* to *diazi,* in males, is steep phenotypically; and (2) reproductive isolation of the overlapping ends is incomplete. . . ."

For the benefit of those to whom a simple statement of the facts is too "informal," I hereby list some taxonomic changes in the mallard group which I then stated or implied to be necessary, and which have not been made in subsequent Check-lists:

Anas platyrhynchos diazi Ridgway.
Anas platyrhynchos fulvigula Ridgway.
Anas platyrhynchos rubripes Brewster.

These and other changes in other groups I still consider necessary. As to *Anas,* neither Johnsgard nor anyone else has produced good evidence that any of the four main forms under discussion is more closely related to any other than to the rest of the group. Thus I perceive no factual basis for his uniting *maculosa* with *platyrhynchos* while keeping it distinct from the more similar *rubripes.* Parkes (*Annals Carnegie Mus.,* 35: 120-121, 1958) has already pointed out that none of these half-way measures gives a good picture of the facts; we must either retain the old A.O.U. arrangement of four species, as Parkes tentatively suggests, or recognize nomenclaturally that we have here a simple open-ring form. The ducks themselves, from New Zealand to the Maritime Provinces (see Boyer, *Can. Field-Nat.,* 73: 1-5, 1959), favor this recognition.

As a side comment, nomenclatural recognition of the obviously close relationship of all these ducks would have the *practical* value of discouraging further squandering of funds for the dubiously useful purpose of mongrelizing the breeds any more than they are already mixed. The ornithologist cannot expect the public to heed the admonition of the facts when he himself fails to express them plainly.

Johnsgard's paper does, however, have one heartening and commendable feature: the mis-named "Hybrid Index" appears here simply as "Index." We are spared from reading that the Mexican and Mottled Ducks are all "hybrids." A hybrid, properly, is and has always been a cross between two distinct biological species, the classical example being the mule. Real hybrids are rare and often sterile. Geneticists have done biology and our language a grave disservice by using the word "hybrid" (instead of cross, intermediate, or mongrel) for a cross between two more-or-less different-looking organisms *within* a species, and ornithologists were ill-advised to follow suit. Since two animals are rarely exactly alike if carefully analyzed, "hybrid" in the geneticists' sense, "hybrid swarms," "hybrid index," "introgression," etc., etc., are meaningless words having nothing to do with true hybrids. The distinction between such commonplace crosses and true hybrids

was very clearly and carefully pointed out a century ago by Darwin, and it is most regrettable that modern zoologists are so unfamiliar with the basic literature of their science! Ornithologists once were well aware of this distinction; for example, Chapman (*Bull. Am. Mus. Nat. Hist.*, 13: 320, 1900) applied the term "intermediates," rather than "hybrids," to what he thought were specimens intermediate between the Eastern and Western Meadowlarks (*Sturnella magna* and *neglecta*), which he supposed to be conspecific. Others would have done well to follow these good examples. The words we read would then have some meaning. Johnsgard's paper marks a slight step in the direction of clarity; let us continue!—ALLAN R. PHILLIPS, *Instituto de Biologia, Universidad Nacional Autónoma de México, México, D.F.*

Sir:

I would like to reply to Dr. Phillips' criticisms of my paper, as they seem to stem mainly from my failure to consider (or cite) his open-ring interpretation of the forms involved. I will consider his arguments in sequence. In Figure 1 breeding Mallard records are indicated by the combination of an upright triangle and a "B," as indicated in the legend. I find no difficulty in locating these symbols on the map. The museums cited were those which I personally visited and where I examined specimens; in the cases of other major waterfowl collections (U.S. National Museum, Chicago Museum, Univ. of Calif.) data on specimens were kindly provided by other persons.

The estimation of gene pools took into account all major wintering areas involving sympatry, with Mallard and Black Duck population estimates being calculated on a state-by-state basis. That the estimations of hybridization incidence did not include all states in which sympatry occurs is regrettable and unavoidable; however, I feel that the numerical estimates, based on nearly 57,000 birds, compare well with estimates of hybridization incidence available for other species (see Miller, 1955, *Recent Advances in Avian Biology*, pp. 1-22). I do not agree that fall and winter population estimates are "worthless," for such estimates indicate degree of sympatry during the period of waterfowl courtship and pair formation when isolating mechanisms must be most effective. In both Mallards and Black Ducks the midwinter period is the time of greatest courtship activity (Johnsgard, *Wils. Bull.*, 72: 133-155; Ramsay, *Wils. Bull.*, 68: 275-281).

I am unaware of any methods which might be used to test the "purity of the strain" of museum specimens other than by measuring the plumage variations in the manner I did; whether such variations are the result of hybridization or individual plumage variations is of course sometimes impossible to determine. To be certain of obtaining only "pure" Black Ducks one would be forced to use only specimens collected north and east of Massachusetts previous to 1900, "pure" Mottled Ducks would be available from only well south of the Mexican border, and scarcely any Florida or Mexican Ducks could be utilized at all.

The "taxonomically useful" characteristics of speculum color and throat streaking may be seen, by the slightest investigation, to be almost valueless. Thus J. Phillips (*Auk*, 29: 295-306) points out: "The speculum color of *diazi* varies, as it does also in *A. platyrhynchos* and *A. tristis*, from a metallic violaceous green to a violaceous purple. This difference has apparently nothing to do with age or sex and is not a character of specific importance, except within wide bounds. It seems to have been used too frequently in describing species differences." Kortright (*Ducks, Geese and Swans of North America*, p. 171) says of the Florida

Duck's speculum: "Variable, from green with strong purplish gloss to almost solid purple. . . ." Cheek and throat streaking varies both in extensiveness of the brownish streaking and the degree of streaking in exactly the same way that the larger body feathers vary in the proportions of dark and light coloration. As the latter was easier to judge quantitatively I used it. Reference to the original descriptions of the Florida Duck (Ridgway, *Amer. Nat.*, 8: 108-111), Mexican Duck (Ridgway, *Auk*, 3: 331-333) and Mottled Duck (Sennett, *Auk*, 6: 263-265) would convince Dr. Phillips that the variations in body mottling and relative amounts of fulvous, ochraceous or dusky body coloration were major bases for the erection of these forms.

There is no evidence whatsoever that sexual dimorphism in the mallard group is spreading out geographically; *A. p. platyrhynchos* and *A. p. conboschas* are the only two of the 20 forms of mallard-like ducks which exhibit strong sexual dimorphism. In common with the other *Anas* species the trend in mallards is towards loss of sexual dimorphism wherever allopatric populations are formed (see Sibley, *Condor*, 59: 166-191).

Dr. Phillips may feel justified in thinking that I did not contribute any major "original taxonomic comments" as a result of my studies, and thus have no basis for my conclusions and suggested taxonomic changes. I would, however, like to point out that the four possible changes in the A.O.U. *Check-list* which I suggested were the result of three years' full-time study. Dr. Phillips has recommended three changes for the mallard group in the *Check-list* without presenting any original evidence and ignoring much of the evidence which is available. In discussing the mallard group, for example, he cites only one reference (Bent's *Life Histories of North American Wild Fowl*). I am not suggesting, however, that I disagree with his proposed changes. We are in fact in essential agreement regarding the conspecificity of the mallard-like ducks. I regret that I was unaware of his 1959 proposals that *rubripes* be considered conspecific with *A. platyrhynchos* and that the whole group of North American forms might be an example of the "open-ring" type of speciation. I considered the open-ring possibility at the onset of my own studies, but soon discarded the idea as unsupported by the evidence. My primary objection to it is that it requires a major geographic barrier around which the "ring" can be formed. Dr. Phillips hypothesizes the Great Plains prairies as such a barrier ("The open ring thus surrounds the unoccupied Great Plains area"), yet how these prairies, which are the most favored of all types of waterfowl habitat, could serve as such a barrier, remains inexplicable to me. In addition, the Florida Duck should, by this explanation, be the Black Duck's closest relative, yet Delacour (*The Waterfowl of the World*, Vol. 2, p. 53) states that if given the opportunity Florida Ducks will mate with Mallards in preference to Black Ducks. Furthermore, if the Florida Duck gave rise to the Black Duck then one would expect that a greater overlap of features should exist between them. Instead, they differ markedly in plumage and ecology. However, as indicated in my paper, I favor only subspecific recognition of all the forms concerned. Dr. Phillips and I therefore differ primarily in the hypothesized mechanism of speciation.

I agree that "hybrid" is a term that strictly speaking should refer to species crosses. However, since there is a continuous genetic gradient between two individuals and two species and thus the point at which complete speciation has been achieved must always be a subjective judgment, I believe that it is not practical to hold to this definition. Since Mexican, Florida and Mottled ducks are

obviously not the result of secondary contact between Mallards and Black Ducks they would in any case not be "hybrids."—PAUL A. JOHNSGARD.

Dear Sir:

After seeing my note (*Auk*, 78: 275) David K. Wetherbee called my attention to his paper (1959 *Bird Banding*, 30: 119-121) entitled "Egg teeth and hatched shells of various bird species," which should have been referenced in my note. He has described a normal second egg tooth on the lower bill of Mourning Doves that has a posteriorly directed point. His description matches my observations on a recent Mourning Dove squab that I examined from the day of hatching. The normal egg tooth on the lower bill has persisted over a week. The structure pictured in my note in *Auk*, however, is larger, did not possess a posteriorly directed point, and is of a different texture (more calcified?). I believe the structure I pictured is an aberrant form of the normal lower egg tooth.—WILMER J. MILLER.

THE AUK

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